A STUDY OF PLEISTOCENE LAKE EDMONTON

AND ASSOCIATED DEPOSITS

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A STUDY OF PLEISTOCENE LAKE EDMONTON AND ASSOCIATED DEPOSITS

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ABSTRACT

The Pleistocene sediments in the vicinity of the City of Edmonton were mapped on a scale of two miles to one inch. The results of this mapping, combined with a study of aerial photographs and some mechanical analyses, were used in an effort to determine the history of the lake, defined as Lake Edmonton, which existed in this area during the retreat of the continental ice sheet, and the genesis of deposits associated with this lake.

Lake Edmonton deposits were found to have covered an area of approximately 870 square miles within the map area, and to have extended an undetermined distance beyond the map area to the north, south and possibly the west. Lake Edmonton was blocked by glacial ice on its eastern shoreline and probably, in part, on its northern and southern shoreline.

The history of Lake Edmonton was divided into two stages. Stage I began when the wasting of the continental ice sheet had proceeded far enough to permit the deposition of the first permanent lacustrine materials within the area, and finished with the incision of the Gwynne Outlet and partial draining of the lake. Stage II began at this point and ended when further wasting of the ice in the northeast permitted complete draining of the lake.

Lake deposits of Stage I consist of material derived from the adjacent ice and from the large delta built into the lake from the west. Deposits of Stage II also consist of material from the adjacent ice and a lesser amount from the delta to the west. Earlier deposits were modified by the drop in lake level caused by the incision of Gwynne Outlet, the action of inwash waters from the west and later wind action.

ACKNOWLEDGMENTS

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This thesis was written while the author was employed by the Research Council and would not have been possible without the funds and equipment the Council made available.

Information supplied by the Alberta Soil Survey was most helpful; it is acknowledged at the appropriate place in the text.

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CHAPTER I

INTRODUCTION

General Statement

This thesis presents the results of a summer's work mapping the glacial deposits* of an area surrounding the City of Edmonton, and the subsequent analysis of samples and interpretation of field and laboratory data. This project, done in 1958, is a part of the general Pleistocene mapping program of the Research Council of Alberta.

For the purpose of this thesis, Lake Edmonton is defined as that lake which existed in the immediate vicinity of Edmonton during the retreat of the last continental ice from the area.

Location of District

The Edmonton district is located in central Alberta between longitudes 113°00' and 114°00' W., and latitudes 53°15' and 53°45' N. (Figure 1). The total area of the district comprises about 1390 square miles.

Previous Work

Lake deposits in the vicinity of Edmonton were noticed

* A glossary of specialized terms used in this paper is included as Appendix B, p. 59

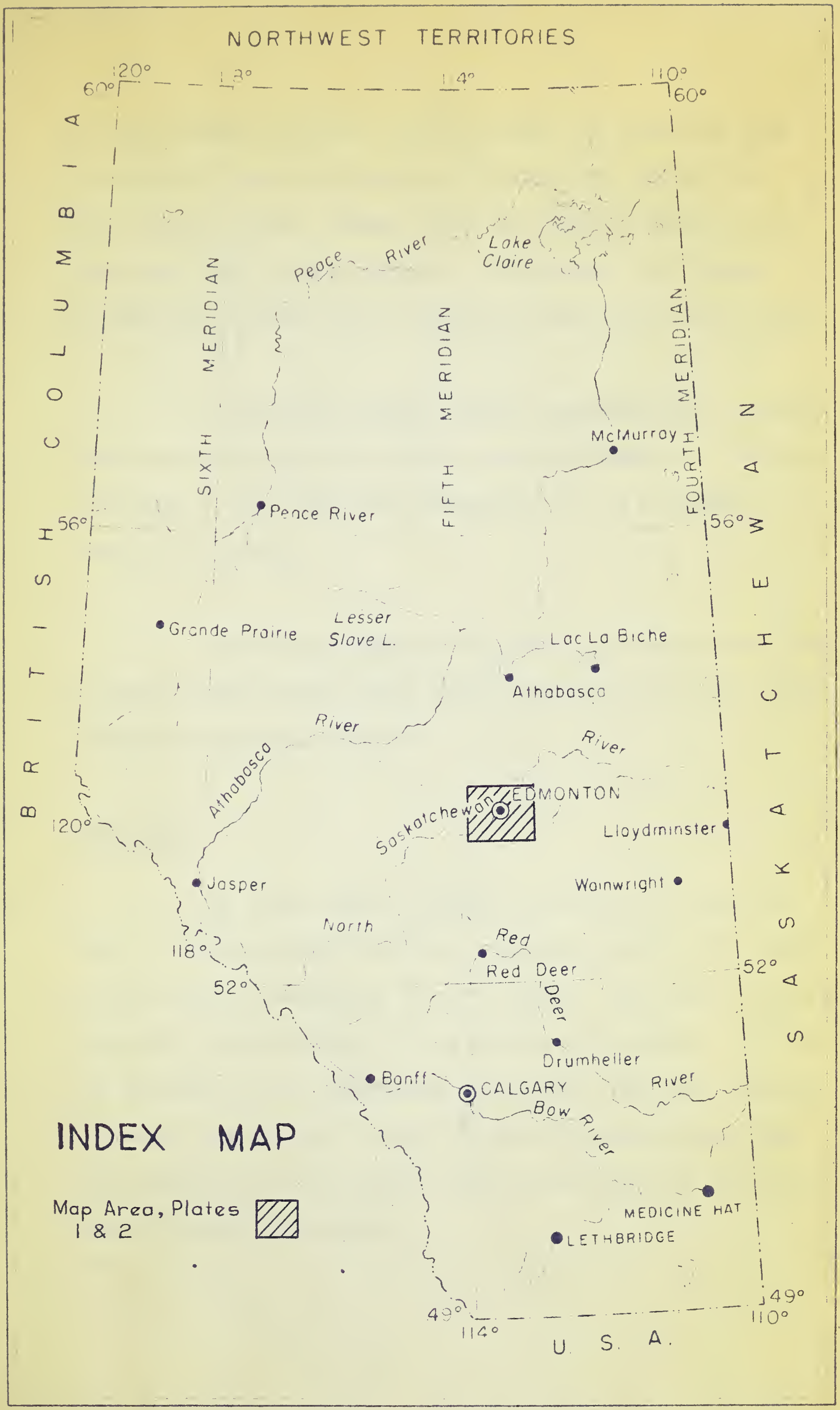
NORTHWEST TERRITORIES
BRITISH COLUMBIA
SASKATCHEWAN
U. S. A.
120°
118°
114°
110°
60°
56°
52°
49°
SIXTH MERIDIAN
FIFTH MERIDIAN
FOURTH MERIDIAN
Peace River
Lake Claire
McMurray
Peace River
Grande Prairie
Lesser Slave L.
Lac La Biche
Athabasca
Athabasca River
EDMONTON
Saskatchewan River
Lloydminster
Jasper
Wainwright
North
Red
Red Deer
Deer
Drumheller
Banff
CALGARY
Bow River
River
MEDICINE HAT
LETHBRIDGE
INDEX MAP
Map Area, Plates 1 & 2

Fig. 1

as early as 1886 by Tyrrell (1887, p.143E) who attributed them to proglacial lakes or remnants of a retreating glacial sea. Dawson (1899, p.14A), Coleman (1910, p.7), Taylor (1934, p.52), Rutherford (1937, p.86) and Warren (1937, p.301) were aware of these lake deposits but no specific studies of them were made.

Later, Warren (1954, p.80-81) and Duff (1955) studied these beds and considered them to represent deposits of the last till sheet to cover the area and deposits of the preceding interglacial period.

The term Lake Edmonton was first used in print in 1956 by Gravenor and Bayrock (1956, p.10) referring to the lake which drained through Gwynne Outlet.

Field Work

The field work was carried out during the summer of 1958. The mapping was done by, or under the direct supervision of, L.A. Bayrock during the first six weeks; the writer continued the mapping independently for the following 2½ months. Information was collected by the examination of road cuts and river sections, by shallow digging, and through the study of aerial photographs. These photographs were procured from the Department of Lands and Forests, Province of Alberta.

All deposits present were mapped on the National Topographic Series Sheets 83H, 5, 6, 11 and 12 at a scale of two miles to one inch (Plate I). Roads were covered on a one mile by two mile grid over most of the lake boundaries, and a two mile by two mile grid over much of the remainder of the area. The main exception was the moraine to the southeast over which few traverses were run. Approximately 1100 miles were covered in these traverses.

CHAPTER II

PHYSIOGRAPHY

General statement

The map area may be divided into six physiographic areas and three physiographic units as follows :

Physiographic areas :

1. Dune Area
2. Reworked Inwash Area
3. Pitted-Inwash Area
4. Ground Moraine Area
5. Hummocky Dead-Ice Moraine Area
6. Lake Edmonton Area

Physiographic units :

The Gwynne Outlet

The North Saskatchewan River Valley

The Sturgeon River Valley

Physiographic areas :

Three major areas of dunes are present, all lying southwest of Edmonton in the west-central section of the map area. The largest area lies due east of the distributaries found in

Twp. 51-27 W4 and extends from them eastward to the North Saskatchewan River. The dunes are widely spaced in the west, and become more closely spaced to the east in Twp. 51-26 W4 with small lakes and swamps often occupying the inter-dune areas. The dunes are longitudinal and parabolic (or U-shaped); the parabolic dunes are concentrated towards the central part of the dune area, and the longitudinal dunes along the northeast boundary. Few of the dunes exceed forty feet in height; some longitudinal dunes reach a length of two miles.

Immediately north of the main dune area, in the southeast corner of Twp.52-26 W4, lies a smaller dune area also composed of longitudinal and parabolic dunes. One longitudinal dune in this area reaches a length of over three miles, but in all other respects the two areas are similar. The dunes in the area west and south of the town of Devon in the north-central part of Twp.50-26 W4, are also similar to those in the main dune area.

The reworked inwash area covers the west-central section of the map area, extending northward from the North Saskatchewan River and crossing the valley of Atim Creek into Township 53 in the north. To the southeast, the reworked inwash area grades into the dune area. Most of the section is covered

by low smooth ridges with a local relief of less than twenty feet, and is crossed by broad shallow, poorly defined channels. Centred about Twp. 51-27 W4 within the inwash area, is a series of anastomosing channels usually less than twenty feet in depth and an eighth of a mile to a mile in width. These channels usually contain bogs and small lakes.

Two areas of pitted-inwash are present. The larger lies in the Winterburn-Acheson area west of Edmonton, and is bounded by a poorly-defined inwash channel on the west and a well-defined scoured channel on the east. At first glance the larger area of pitted-inwash resembles the knob and kettle topography of the hummocky dead-ice moraine, but, upon closer examination, it is seen to be composed of closely spaced pits up to forty feet deep. These pits tend to become smaller toward the edge of the area.

The second area of pitted-inwash lies one and a half miles to the northwest of the first, in the valley of Atim Creek, and is separated from the first by an area of marsh. This marshy area represents an extension of the poorly-defined inwash channel lying to the west of the first area of pitted-inwash. Although similar to the first, the second area of pitted-inwash differs in that the pits have been partially filled with flat-lying inwash and recent sediments, leaving scattered knobs about ten to fifteen feet high with flat areas between.

An area of ground moraine lies to the east of Edmonton extending to the northeast corner of the map area. Its surface is gently undulating with scattered kettles; the local relief varies from twenty to forty feet. This ground moraine is transitional into the hummocky dead-ice moraine to the south. Small patches of similar ground moraine are dispersed throughout the map area.

The hummocky dead-ice moraine area lies in the southeast portion of the map area. The main physiographic features making up this moraine are knobs, prairie mounds, kettles, ridges and stream trenches. Similar features have been described in detail by Gravenor and Ellwood (1957, p.12-14) in the Sedgwick district of Alberta.

A similar, but smaller area of hummocky dead-ice moraine is located in the northwest corner of the map area.

The Lake Edmonton area is the largest physiographic area mapped. It is flat throughout most of its extent, but in some places, particularly near shorelines, pre-lake topography is still marked, although subdued by overlying lake deposits. Prairie mounds and other features of hummocky dead-ice moraine, although covered by twenty feet of lake sediments, are commonly discernible with remarkable clarity on aerial photographs. Pre-Lake

Edmonton topography is dominant in the Calmar-Nisku area. A broad ridge extends through Calmar northward to the North Saskatchewan River; east of this ridge is a broad shallow valley containing Whitemud Creek, and farther eastward the country rises gently until cut by the Gwynne Outlet. Some low longitudinal dunes occur in the Oliver area northeast of Edmonton. Scoured channels less than five feet deep are present to the west of Edmonton, and also to the south of the North Saskatchewan River west of Devon.

Physiographic units :

The Gwynne Outlet was originally defined by Gravenor and Bayrock (1956, p.9) as the outlet of Lake Edmonton. Only that part of the Gwynne Outlet channel occurring within the area mapped is discussed here. This channel is located in the south-central section of the map area and is at present in part occupied by Saunders Lake in the south, and Blackmud Creek in the north. East of Leduc the valley of the outlet channel is 125 to 150 feet deep and one-half mile wide, with steep walls and a flat bottom. To the north, the valley becomes broader and shallower, and is completely indistinguishable at a point about four miles north of Nisku in Sec. 7-51-24 W4. A number of subsidiary channels are associated with the Gwynne Outlet in the Edmonton area but, with

the exception of one which lies about two miles to the east and joins the outlet channel just south of the southern boundary of the map area, they are poorly defined.

The North Saskatchewan River is the main drainage channel of the area. It enters the map area in the southwest and leaves it in the northeast, and passes diagonally through Edmonton. The river valley itself can be divided into two sections, the break occurring close to the railway bridge just west of Cloverbar in Sec. 18-53-23 W4. Upstream from this bridge the valley seldom exceeds one mile in width, the valley walls dropping two hundred feet within one-eighth to one-quarter mile. Downstream from the Cloverbar Bridge, the valley is seldom less than one and a half miles wide, and the valley walls are usually less than 125 feet in height. Upstream from the Cloverbar Bridge meander spurs are still present, while downstream the spurs have been almost completely removed. West of Fort Saskatchewan the valley is less than one hundred feet deep; its banks slope gently down to the river.

The Sturgeon River enters the map area in the northwest corner, then flows east and south to enter Big Lake. From Big Lake the Sturgeon River flows northeast to leave the map area north of Edmonton. The valley of the Sturgeon River upstream from Big Lake is less than ten feet deep and fifty feet wide.

From Big Lake downstream, the valley takes on an entirely different character, being about one hundred feet deep and one and a half miles wide, with the underfit Sturgeon River meandering through it. Here the valley seems to be more closely related to the valley containing Big Lake and Atim Creek to the west, than to the valley containing the Sturgeon River north of Big Lake.

CHAPTER III

DESCRIPTION OF MATERIALS

The Edmonton formation underlies most of the map area but pinches out in Sec. 23-54-23 W4 in the North Saskatchewan River valley (Map 102A, Geol.Sur.Canada, 1951). This formation is Upper Cretaceous in age and dips at about twenty feet per mile to the southwest. It is composed of interbedded soft bentonitic shales and sandstones, with some coal seams, and it is quite incompetent. It has been badly deformed by overriding ice at some localities. There is some doubt as to the existence of the Bearpaw formation below the Edmonton formation. Map 102A shows Bearpaw outcrops in Sec. 23-54-23 W4 but Ower (1958, p.7) could not find it at this locality. Outcrops of Belly River formation are shown on Map 102A downstream from Sec. 23-54-23 W4 on the North Saskatchewan River. The combined thickness of the above mentioned formations in the California Standard-Winterburn Province #1 well in Lsd. 10-4-53-25 W4 is 1650 feet.

The Saskatchewan sands and gravels discontinuously overlie the Edmonton formation, and reach a maximum thickness of 30 feet within the map area. Inasmuch as no fossils have as yet been described from this unit, its age is doubtful.

The Alberta Soil Survey has collected and mechanically analysed material from scattered locations throughout the map area. The results of these analyses are on pages 43 to 48 and the locations are marked S on Plate I.

Under the heading of Ground Moraine is included normal ground moraine with a swell and swale surface and those till deposits which have no characteristic surface expression because of erosion, or because of the deposition of overlying lake sediments. The largest area of ground moraine extends from Twp. 52-23 W4 to the northeast corner of the map area, with other small patches scattered throughout the district. No mechanical analyses were run on the ground moraine, but inspection of exposures and examination of hand samples in the field showed considerable variation in textural composition of the ground moraine material.

A normal till comprises about ninety percent of the mapped ground moraine. It is composed of about equal parts of sand, silt and clay, with numerous pebbles and boulders. Many of the latter are obvious lying upon the surface of vegetation-free fields in areas mantled by this till. The colour of this till is light brown where oxidized and grey to dark brown where unoxidized.

A sandy till commonly occurs near the lake border and is often found within the Transition Zone. Some of the clay and silt fractions are missing, leaving a very sandy material which grades toward an impure gravel. All gradations between normal till and sandy till have been found.

Near the lake boundary and within the Transition Zone is a material which exhibits all the characteristics of till, except that it contains very few stones. This stone-poor till is thought to have been ice-rafted or to have slumped from the surrounding ice into the lake. Hartshorn (1958) describes a similar material in Massachusetts. In many cases material of this nature was found to exhibit a poorly developed stratification. The deposition of less than two feet of lake sediments over till may obscure the surface stones and, unless a good exposure is present, the material could be mistaken for a stone-poor till.

The occurrence of any or all of these till types associated with Lake Edmonton deposits is common within the Transition Zone (Fig.2 p.17).

The hummocky dead-ice moraine is found in the southeast corner of the map area. The till forming the dead-ice moraine is generally stonier than that of the ground moraine. It contains lenses of sand and gravel and inclusions of contorted bedrock and

superglacial lake deposits.

A small kame moraine is located in the northwest section of the map area, centring about Sec. 7-54-27 W4. It is composed of till and sand with some minor pockets of gravel.

Superglacial lacustrine deposits are restricted to the eastern half of the map area. These deposits vary from one hundred feet to over ten miles in length and are often less than one foot thick. They can be divided into two classes. The first, the larger lake deposits, consist of bedded clays with some silts and ice-rafted stones. The bedding is, for the most part, undisturbed. The second, the small lake deposits, consist of clay, silt, sand and ice-rafted stones and are often included within the knobs of the hummocky dead-ice moraine. Fossils are commonly present and bedding is often badly distorted.

These two types of superglacial lake deposits conform to the underlying hummocky dead-ice topography, having very little if any surface expression of their own. The outlines of these lakes have been copied from the Edmonton sheet of The Alberta Soil Survey (in preparation); the writer is indebted to the Survey for this information.

Lake Edmonton deposits are found throughout the central and northern sections of the map area and in its southwest corner. They consist mainly of bedded silts and clay with some sand. Ice-rafted stones are common and till inclusions are sometimes present. Fossils were found in one location in Lsd. 14-33-54-22 W4. Generally speaking, the grain size of these deposits decreases towards the top of the section and the clay content increases, while the base of the section is often sandy and transitional into the underlying till. Results of the mechanical analyses of the lake sediments can be found in the Appendix (Figs. 4 to 13, p. 49 to 58). Beds range from two feet to one-eighth of an inch thick, or less. Often beds, or groups of beds, are continuous over a distance of one hundred yards and some have been observed to extend farther. Distorted bedding, presumably at least partly caused by floating icebergs, is found in many sections (Fig. 3).

The Transition Zone lies along the north and eastern shores of Lake Edmonton where the individual till and lake deposits become too small to map as isolated bodies. Lake deposits in this zone are often slightly sandier than normal and contain more ice-rafted material. The till deposits consist of normal till, stone-poor till and sandy till, as described on pages 13 and 14. Outwash and beach deposits also occur within this zone but will be discussed later.

Figure 2 : Transition zone. Dark bands are till, lighter bands lacustrine sand and silt. Lsd. 7-14-52-25 W4.

Figure 3 : Contorted Lake Edmonton sediments. Lsd. 8-26-51-25 W4.

Water-reworked material overlying Lake Edmonton deposits is found north of the town of Ireton in the west half of Twp. 50-25 W4, and in the east quarter of Twp. 50-26 W4. This material consists of a poorly-sorted mixture of sand, silt and clay, sand being the dominant fraction. The maximum thickness of these deposits seldom exceeds four feet and is usually less than eighteen inches. Bedding is very faint or absent, but a thin discontinuous layer of stones was seen in many exposures at the base of this deposit.

Two areas of water-reworked material over till exist, both having a similar lithology. One area lies northeast of the town of Calmar in Twp. 50-26 W4. The other includes the town of Leduc and extends to the northeast as far as the town of Ellerslie. These materials are quite similar to the water-reworked material overlying Lake Edmonton deposits, described above, but differ in having a slightly coarser texture. The water-reworked material overlying till is a poorly sorted sand, silt and clay mixture, usually less than two feet thick, and often containing gravel near the base. This gravel, at one location, has a thickness of four feet. Bedding is poorly defined in all the water-reworked materials.

The water-reworked inwash deposits lie in the west-central part of the map area comprising most of Twp. 52-26 W4,

all of Twps. 51 and 52, Rge. 27 and parts of the adjoining townships. This material consists of fine- to medium-grained sand, with some silt and clay, and occasional bands of coarse sand and fine gravel. Ice-rafted stones and inclusions of till-like material are not uncommon. Bedding is present in all sections, with individual beds usually being less than six inches thick.

Two areas of pitted-inwash are present, one, three miles west of Edmonton, and the other, one mile to the northwest of the first area in the valley of Atim Creek. These deposits are similar in textural composition to the water-reworked inwash deposits. Fossils have been found at two localities in these deposits.

Sand and gravel outwash is found along the east shore of Lake Edmonton. Well-sorted sand is the dominant fraction of these deposits, but fine gravel is present in minor amounts. Well-developed cross-bedding and channel infill structures are often discernible. Other outwash is present in Twp. 54-27 W4 in the Gladu Lake area. This material is generally a poorly-sorted fine- to coarse-grained sandy gravel. Sand lenses are present but rare. No good sections through this gravel were found and thickness and bedding were not determined.

Four deposits of fluvial-lacustrine sands have been mapped. The largest deposit lies beside the North Saskatchewan River Valley along most of its length in the mapped area. The second deposit occurs beside the Sturgeon River in the northwest corner of the map area. Two other deposits lie north and west of Big Lake, partly covering Sections 30 and 31-53-26 W4. These sands vary from fine- to coarse-grained and contain some clay and silt. In one exposure near the top of the valley wall of the North Saskatchewan River, in Lsd. 12-17-53-23 W4, a gravel channel infill was encountered associated with this sand. The maximum thickness of fluvial-lacustrine sand observed was fifteen feet but in general the thickness was less than three feet.

Five deposits of aeolian sand occur in the map area. Three lie southwest of Edmonton in the Devon-Woodbend areas, the fourth in the Oliver area and the last is present in Sec. 7-55-22 W4. These deposits consist of fine- to medium-grained sands with silt and very little clay. Their thicknesses vary from less than one foot to over forty feet. Bedding is poorly defined near the surface where soil-forming processes have partially obliterated it, but well defined in the deeper sections.

Scattered through the area, the recent lacustrine deposits are made up primarily of clay, silt and some sand. Muck occurs in most deposits and both marl and peat are often found.

Steep slopes are almost always covered with colluvium. As would be expected, the composition and thickness of the colluvium are extremely variable. Slump blocks fifty feet in width and three hundred feet long are common along the North Saskatchewan River.

The main deposits of recent alluvial material occur within the North Saskatchewan River valley. They consist of gravel, sand and silt. Other recent alluvial deposits occur along the smaller streams throughout the area.

Fossils were discovered at the locations marked on the map (Pl. I). Preliminary investigation showed the presence of ostracods, gastropods and pelecypods, but time was not available for further studies.

CHAPTER IV

PLEISTOCENE AND RECENT HISTORY

Introduction :

Accurate reconstruction of the pre-glacial topography of the area is difficult ; however, some general statements can be made. The last pre-glacial deposits in the area consist of Saskatchewan gravels and sands. Although little is known of the origin of these gravels, Beach (1934, p.63-64) has described some occurrences as channel fillings in underlying Cretaceous sediments. The writer observed similar channel fillings of Saskatchewan gravels in the field. Bedrock outcrops are found in most of the higher areas and quite commonly in the North Saskatchewan River valley. This would indicate a pre-glacial topography similar, in a broad sense, to that of the present day, but perhaps having slightly more local relief.

Flutings mapped in Sections 8, 9 and 10-54-24 W4 and previously mentioned by Gravenor and Ellwood (1957, p. 26), indicate that the last ice advanced over the Edmonton area from a northeasterly direction. This agrees with the results of investigations by Gravenor and Bayrock, (1955, p. 1325) postulating a direction of ice advance in northern and central Alberta of S.30°W.

An approximate ice thickness of 3500 feet has been

suggested by Bayrock (1958a, p. 16-17) in the Alliance Brownfield district of Alberta, one hundred miles southeast of Edmonton, and the ice in the Edmonton area is assumed by the present writer to have had about the same thickness.

A radiocarbon date on a log found in the only till in the Smoky Lake district, about fifty miles northeast of Edmonton, gave an age of 21,600 ± 900 years, (Gravenor and Ellwood, 1956, p. 4). If this age is correct, the last ice advance in this district would have been in Wisconsin time.

Recent reports (Gravenor and Ellwood, 1957, p.28; Bayrock, 1958a, p.28; Bayrock, 1958b, p.19) indicate that deglaciation of the central and eastern sections of Alberta occurred by stagnation of the ice rather than by a frontal retreat.

History of Lake Edmonton and related deposits :

Lake Edmonton was formed as a proglacial lake during the stagnation of the continental ice sheet in the Edmonton area.

Oral communications (1958, L.A. Bayrock, J.F. Jones, S. Pawluk, all of the Research Council of Alberta) indicate that some of northern Alberta is covered by lake sediments similar to those in the Edmonton district, and that Lake Edmonton probably

comprises only a small part of a larger lake formed during the deglaciation of Alberta.

For convenience, the history of the deposits in the map area has been divided into two stages (Pl.II) :

Stage I commenced when the mass of ice comprising the continental ice sheet in the Edmonton area had wasted enough to allow deposition of lacustrine sediments directly on the underlying moraine. Expansion of the lake continued as the surrounding ice melted, the lake reaching its maximum size during this Stage. The maximum elevation of Lake Edmonton deposits found in the map area is between 2400 and 2425 feet. With the incision of Gwynne Outlet and the subsequent drop in lake level to an elevation of approximately 2265 feet, Stage I came to an end. Stage II of Lake Edmonton came to an end when further down-wasting of the ice in the northeast made lower level outlets available and eventually permitted the incision of the North Saskatchewan River and the complete draining of the lake. Plate II outlines areas in which ice is thought to have existed in both Stage I and Stage II.

No outlet has been discovered in the map area which could have drained Lake Edmonton during Stage I, but as lake sediments have been found at an elevation of slightly over 2400 feet, any outlet present must have been higher than this level.

In the following pages the sediments associated with Lake Edmonton will be discussed in detail in the order of their chronologic appearance within the framework of the Stages outlined above.

Stage I :

As the continental glacier melted, the first sediments exposed in the area would have been deposited in superglacial lakes. Both these lakes and their deposits were transitory. The earliest Lake Edmonton probably developed from one of these superglacial lakes which, through continued melting of the ice, came to lie directly on the underlying moraine in a favorable locality.

During this early period ground moraine would be continuously exposed by the melting ice. In all cases within the map area, this Stage I ground moraine is thought to have been immediately covered by Lake Edmonton.

The hummocky dead-ice moraine would also be forming as the ice melted during Stage I, and, as with the ground moraine, covered by lake deposits. As mentioned on page 8, surface features of this moraine covered by up to 20 feet of lake sediments are visible on aerial photographs.

No Stage I kame moraine has been discovered in the map area, but if any had formed in this Stage it would also have been mantled by lake sediments.

During Stage I Lake Edmonton proper steadily expanded as the ice on the shores, and ice-islands in the lake melted. Sediments were washed into the lake from a number of sources. Debris from the surrounding ice was delivered to the transition zone by melt-water streams, and incorporated into the lake deposits. Other debris was rafted by icebergs and shore ice. Material was also contributed from the reworked inwash area, which will be discussed later.

No record of the break between Stages I and II could be found within the lake deposits proper, so the following discussion applies to both Stages.

In general, the individual beds are thicker and more silty near the base of the lake deposits, becoming thinner with a higher clay content near the top. This would indicate more rapid deposition of coarser materials in early Stage I. Thin relatively pure clay bands may indicate periods when all contributing streams froze and only the fine fraction in suspension was available for deposition. The maximum number of these clay bands counted was forty in Lsd. 9-26-51-25 W4, and, if they represent parts of annual deposits (varves), forty years would be

the minimum life of Lake Edmonton at that point. The lowest lake deposits found were at an elevation of 2050 feet; the highest at approximately 2415 feet. This indicates the water in Lake Edmonton may have reached a depth of 365 feet at one time. The presence of ice-rafted stones and of contorted bedding (Fig.3, p.17) in the lake sediments indicates floating ice was common. The number of ice-rafted stones varies from section to section and a study of their distribution may suggest the wind direction at the time.

The transition zone is considered to represent the shoreline of the expanding Lake Edmonton migrating outward with the retreat of the ice along the shores. Deposition here formed the basal deposit of the lake. Most certainly some of the transition zone deposits represent winnowing of the underlying till, beach deposits, the deltas of small melt-water streams and slumping from the surrounding ice but, as the individual deposits cannot be separated, they have been mapped as a unit.

A rather complicated series of events is believed to be responsible for the deposition of the large mass of material lying to the west of Edmonton and mapped as water-reworked inwash and pitted-inwash. It is believed that during Stage I a delta was built into Lake Edmonton from the west. Deposits of this delta, which transgressed over pre-existing lake sediments, extend

westward from Winterburn (four miles west of Edmonton) for a distance of 28 miles into Twp. 52-3 W5, well outside the map area. Within the Edmonton area the deltaic materials underlie the aeolian sands north of the North Saskatchewan River, and the water-reworked inwash deposits, and make up the pitted-inwash deposits in the Winterburn area and in the valley of Atim Creek. To the west of the map area in the St. Anne district, this deposit has been mapped by Collins and Swan (1955) as "Moraine - silt till in part bedded". Deltaic deposits are also believed to underlie material mapped by Collins and Swan as beach sand and silt. This beach sand and silt, in turn, is believed to be contiguous with the material mapped here as water-reworked inwash.

This inwash material has been interpreted as a delta for the following reasons. The material mapped as pitted-inwash within the Edmonton area is very similar in surface relief, bedding and composition to that mapped as "Silt Till" by Collins and Swan. This is based on personal observations made on a trip through the St. Anne area, from information contained in the Collins and Swan report on the area, and a description of the material by Bretz (1943, p.36). The pits dotting the surface of the material are attributed by the present writer to the deposition of sediments around ice blocks and the subsequent melting of the ice in Stage II. The till inclusions found in the material are thought to have slumped from this ice or to have been rafted into position by floating ice. The stones found are attributed to ice-rafting.

The disposition of these materials along 28 miles of what is believed to have been the main inlet to Lake Edmonton in Stage I and their plan shape, support the delta concept. The materials themselves and their bedding, although indistinct in some sections, would be expected in such a delta.

With the drop in lake level at the end of Stage I, the building of the delta ceased and erosion took place.

The outwash deposits in the Gladu Lake area were laid down by melt-water flowing from ice on the higher land to the north, the east and the west. These deposits lie above 2275 feet, and are covered by up to two feet of lacustrine clay in some places, indicating deposition of these outwash deposits late in Stage I.

In the Nisku-Calmar area towards the south-central section of the map area, a large area has been mapped as water-reworked material overlying Lake Edmonton deposits or till. This material was derived during the last phase of Stage I. Two factors combine to make this area unique within the map area. Firstly, in this area the incision of the Gwynne Outlet resulted in a drop in lake level and a receding shoreline which, while retreating across pre-existing deposits, modified them considerably. Thick glacial ice is thought to have bordered Lake Edmonton

throughout most of the rest of the map area, and the drop in lake level resulted in little lateral shoreline movement. The inwash areas were exceptions to the above in that they were ice-free at this time. Secondly, this area has not been modified to any extent since this drop in lake level and the effects of this retreating shoreline are still visible.

To add clarity to the following discussion of the genesis of the water-reworked material, it has been subdivided into three smaller areas. The first area of water-reworked material over till centres about Twp. 50-26 W4 northeast of the town of Calmar. The surface gradient in this area is greater than in the area of water-reworked material over lake sediments to the east, consequently, erosion was more pronounced here. As a result, most of the earlier Lake Edmonton deposits were removed during the retreat of the Lake Edmonton shoreline, exposing the underlying till. The sandy material left on the surface is primarily the result of winnowing of both till and lake deposits by current and wave action.

The second area of water-reworked material over till lies in Twps. 50 and 51, Rges. 24 and 25 and includes the towns of Leduc and Nisku. The retreating lake waters were not as effective in this area, probably because shore ice was still present in many places. The main erosive factor seems to have been the

current action caused by water flowing toward the Gwynne Outlet from the lake basin proper and from the hummocky dead-ice moraine to the east. Aerial photographs reveal scouring in the southeast part of Twp. 51-24 W4, and the northeast part of Twp. 50-25 W4, and channelling is evident on both sides of the Gwynne Outlet valley, south of this.

The area of water-reworked material over lake sediments lies between the first two, centred about the east side of Twp. 50-26 and the west half of Twp. 50-25 and extending to the north and south. This area was not eroded as severely as the other two areas because of its low relief; some Lake Edmonton sediments are still in place below the overlying sandy deposits. Much of the sandy overburden in the southern part of this area was carried from the higher area to the west by current and wave action.

Stage II

The wasting of the ice continued through Stage II, exposing more ground moraine and building kame and hummocky dead-ice moraine. Ice is known to have formed the lake shore towards the northeast corner of the map area during this Stage, as Lake Edmonton sediments are absent in some areas lower than 2265 feet (Pl.II). There is no reason to suspect ice remnants

were not present in other parts of the map area. The above evidence, coupled with the fact that ice-rafted debris is common in the youngest lake sediments, would indicate that ice persisted in the area after Stage II was over and that the kame moraine and part of the hummocky dead-ice moraine may have been formed after Lake Edmonton had completely drained.

Lake Edmonton deposits proper were discussed under Stage I and little can be added here. It could be pointed out that because beaches are absent in areas known to have been free of glacial ice during Stage II, the last stage of Lake Edmonton was probably of short duration. Transition zone deposits were also discussed with Stage I deposits. Their formation continued throughout Stage II in much the same manner as in Stage I and will not be discussed further.

During Stage II the two areas of water-reworked material overlying till in the south-central section of the map area may have been affected by colluvial action. This would explain the extreme diversity of this material over small areas.

An examination of the topographic maps suggests the possibility that water could have moved from Sec. 9-51-25 W4 on the North Saskatchewan River across the northern part of the water-reworked material overlying lake deposits, to the Gwynne

Outlet during Stage II. Examination of the water-reworked material between these two points would tend to corroborate this as the sandy deposits become thicker and better sorted in this area. However, definite proof for this is lacking.

Throughout Stage II of Lake Edmonton, stream action modified the delta area and deposited the reworked inwash. The anastomosing channels in the vicinity of Twp. 51-27 W4 originate at the North Saskatchewan River in Twp. 50-1 W5, three miles to the west of the map area. They represent the last pattern of delta distributaries before the North Saskatchewan River had cut a consequent valley below this point. They can be followed both north and south of the North Saskatchewan River into the Edmonton map area. Other evidence of channelling or scouring is present between Winterburn and Stoney Plain; the age of these features is not as clearly defined. Water flowing in these channels eroded the pre-existing inwash and probably much of the pitted-inwash, and deposited a layer of sand over the west-central section of the Edmonton map area.

At every locality where vertical relationships could be observed, with the exception of the area around Gladu Lake previously discussed, the outwash sand deposits overlie Lake Edmonton deposits, the hummocky dead-ice moraine or the ground moraine. These materials were deposited by melt-water streams

flowing from the ice in late Stage II, or even after Lake Edmonton had completely drained.

The superglacial lake deposits shown on Plate I were also deposited towards the end of Stage II, or later. Only those deposits formed on or within the confines of the last remnants of glacial ice would have been preserved. Earlier deposits would have been destroyed as the ice melted.

The fluvial-lacustrine sands are thought to represent both the last deposits of Lake Edmonton and the earliest deposits of the North Saskatchewan River. The deposits bordering the Sturgeon River in the northwest corner of the map area are thought to be a result of increased current action during the final draining of Lake Edmonton. The sand deposits bordering the North Saskatchewan River were deposited during the early stages of the river, prior to the incision of the present valley.

Five areas of dunes exist; the largest centres in Twp. 51-26 and has been derived of the inwash sands. Dunes in the Devon area were derived from the surrounding fluvial-lacustrine sands and those dunes in Twp. 52 Rges. 25 and 26 were derived from sands blown from about the small lake to their northwest. A few isolated dunes are located in Twp. 53, Rges. 23 and 24 W4 near Oliver. Their source was the surrounding fluvial-lacustrine sands.

One dune is present in Sec. 7-55-22 W4, probably also derived from fluvial-lacustrine sands.

The three first-mentioned dune areas lie above the level of Stage II Lake Edmonton and their formation could have been initiated during or after late Stage I. The two last-mentioned dune areas lie below this level and must have been initiated during or after the draining of the Stage II lake. Although the dunes are at present stabilized, dune formation in all the area is believed to have continued until after the cutting of the North Saskatchewan River valley for the following reasons :

1. Dunes occur within twenty-five feet of present river level in Sec. 31-50-26 W4.

2. In Sec. 6-52-25 W4 a gully tributary to the river formed a barrier to the dunes' advance.

Odynsky (1958), studying the shapes of sand dunes in Alberta, believes the winds which formed the dunes in the Edmonton area blew from N.60°W., the direction of the present prevailing wind. Evidence within the map area supports Odynsky's belief. The dunes in the southeast corner of Twp. 52-26 W4 lie approximately S.60°E. of the small lake in Secs.14 and 15, Twp. 52-26 W4, whose surrounding sands were their source.

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APPENDIX A

MECHANICAL ANALYSES :

Mechanical analyses were run on one section through the deposits of Lake Edmonton, in Lsd. 12-36-50-26 W4, using the procedure outlined by Lambe (1951, Chap.IV). Samples were collected at the outcrop from the bottom of the transition zone to the surface. A description of this section can be found on pages 40-41. Mechanical analyses were run on samples numbered 1 to 22 inclusive (Figs.4 to13 , p.49 to 58), and field descriptions were made of the remainder.

Time was saved by using the same sample for both hydrometer and sieve analyses. After the hydrometer analyses were completed, the material was washed through a 300 mesh (Tyler) sieve. The material remaining on the sieve was then dried and used for the sieve analyses. Four replicate size analyses were run on Sample #15 as a check on the accuracy of the method. These are included with the other curves. Calgon was used as a dispersant at a concentration of 0.1% by weight.

Other mechanical analyses, illustrative of the nature of the materials mapped, were procured from the Alberta Soil Survey. They are listed on pages 43-48.

Replicate specific gravity runs were made on Sample #15 using a method outlined by Toogood (1957). The specific gravity of Sample #15 was found to equal 2.74 and this figure was used for the other samples as well.

DESCRIPTION OF COMPLETE SECTION

Location 12-36-50-26 W4*

Sample No. For Mech. Analyses	Base of Section	Transition Zone Base	Description
-	0 - 1'	Sand and silt	Very fine grained sand - $\frac{1}{4}$-1" horizontal beds, clean with iron stained band at 0.5'.
-	1 - 2'	" " "	as above but $\frac{1}{4}$" clay band at 1.1' beneath $\frac{1}{4}$" white limey band.
-	2 - 3'	" " "	very fine-grained sand.
-	3 - 4'	" " "	similar to above but sand approaching fine grained.
-	4 - 5'	" " "	as above.
-	5 - 6'	" " "	very fine grained sand and silt bedding still as above.
-	6 - 7'	" " "	fine grained sand as above.
-	7 - 8'	" " "	as above.
-	8 - 9'	" " "	some cross-bedding and carbonaceous bands.
-	9 - 10'	" " "	as above.
1	10 - 11'	" " "	as above. See Fig. 4.
		Transition Zone - Lake Edmonton Contact	
2	11 - 12'	Silt	poorly bedded silt unconformable on underlying sand - appreciable sand and clay content. See Fig. 4.

* Location shown on Plate I by symbol S

Sample No. for Mech. Analyses	Base of Section	Transition Zone - Lake Edmonton Contact	Description
3	12 - 13'	Silt	bedding distorted, appreciable sand and clay content. See Fig. 4.
4	13 - 14'	"	$\frac{1}{4}$ to $\frac{1}{2}$" beds, clean, few impurities. See Fig. 5.
5	14 - 15'	"	as above but includes band of impure material 2" thick. See Fig. 5.
6	15 - 16'	"	as above, clean and well stratified beds 1/8" to 2" thick. See Fig. 5.
7	16 - 17'	"	as above. See Fig. 6.
8-19	17 - 29.2'	"	as above. See Fig. 6 to 12.
19	29.2-29.6'	"	granular texture due to soil processes; bedding obscured. See Fig. 12.
		Lake Edmonton Fluvial-Lacustrine Sand Contact	
20	29.6- 30'	Silt	fine to medium-grained brown. See Fig.13.
21 & 22	30 - 32'	Sand	as above. See Fig. 13.
-	32 - 33'	"	as above but mixed with organic matter within soil profile.

Top of Section

RESULTS OF MECHANICAL ANALYSES

Lsd. 12-36-50-26 W4.

Figures 4 to 13

Sand : 2.0 mm - 0.05 mm   Silt : 0.05 mm - 0.002 mm

Clay : less than 0.002 mm

Sample	Sand %	Silt %	Clay %
1	51	42	7
2	10	59	31
3	12	59	29
4	6	61	33
5	16	56	28
6	0	71	29
7	2	73	25
8	5	71	24
9	6	74	20
10	6	72	22
11	5	74	21
12	4	70	26
13	3	72	25
14	3	75	22
15	3	76	21
15A	2	76	22
15B	3	72	25
15C	2	73	25
16	3	76	21
17	3	74	23
18	4	70	26
19	4	70	26
20	21	55	24
21	52	31	17
22	54	27	19

MECHANICAL ANALYSES PROCURED FROM THE ALBERTA SOIL SURVEY

Sand : 2.0 mm. - 0.05 mm. Silt : 0.05 mm. - 0.002 mm.

Clay : less than 0.002 mm. Fine clay less than 0.0002 mm. Fine clay included in Total Clay.

1. Location : SW 25-50-25 W4 *

Depth (inches)	Sand %	Silt %	Clay %
0-10	37.4	42.8	19.8
10-12	41.5	46.7	11.8
12-28	34.7	39.3	26.0
28-48	43.8	34.8	21.4
48-60	43.6	35.6	20.8

2. Location : SE 24-50-26 W4

Depth	Sand %	Silt %	Clay %
0-17	32.0	44.0	24.0
17-21	36.5	41.7	21.8
21-31	29.5	45.1	25.3
31-46	36.6	41.5	21.9
46-60	19.1	38.4	42.5
60 +	10.8	38.0	51.2

3. Location : SW 13-51-24 W4

Depth	Sand %	Silt %	Clay %
0-6	20.0	49.0	31.0
6-10.5	21.0	50.0	29.0
10.5-11.5			
11.5-14.5	19.0	47.0	34.0
14.5-20	31.0	34.0	35.0
20-29	36.0	34.0	30.0
29-35			
48 +	31.0	42.0	27.0

* Locations shown on Plate I by symbol S

4. Location : NW 18-51-25 W4

Depth	Sand %	Silt %	Clay %	Fine Clay %
0-14	81.2	12.1	6.7	1.4
14-20	71.2	6.2	22.6	14.1
20-38	84.4	5.6	9.5	6.3
38-60	87.7	3.6	8.7	4.7
60-84	88.0	3.4	8.6	4.7

5. Location : NW¼ 10-51-26 W4

Depth	Sand %	Silt %	Clay %
0-4	88.3	5.4	6.3
4-20	90.9	4.9	4.2
20-36	91.9	3.0	5.1
36-60	91.1	2.7	6.2
60-84	93.1	1.5	5.4

6. Location : SW 6-52-24 W4

Depth	Sand %	Silt %	Clay %
0-5	15.0	40.4	44.6
5-6	16.3	57.7	26.0
6-14	8.1	28.6	63.3
14-22	6.0	27.1	66.9
22	4.6	36.1	59.3

7. Location : SW 5-52-25 W4

Depth	Sand %	Silt %	Clay %	Fine Clay %
0-10	12.8	39.6	47.6	17.3
10-12	35.7	26.6	37.7	17.6
12-24	12.7	28.4	58.9	31.3
24-36	3.8	30.1	66.1	29.9
36-48	2.9	24.4	72.7	23.6

8. Location : NW 20-52-26 W4

Depth	Sand %	Silt %	Clay %
0-18	36.5	49.7	13.8
18-32	53.4	35.1	11.5
32-40	6.5	68.9	24.6
40-70	3.5	77.8	18.7
70-80	11.3	73.8	14.9

9. Location : SW 25-53-24 W4

Depth	Sand %	Silt %	Clay %
0-6	64.5	20.9	14.6
6-8	74.0	18.8	7.2
8-13	69.3	12.7	18.0
13-24	76.7	6.7	16.6
24 +	26.2	40.5	33.3

10. Location : SW 7-53-25 W4

Depth	Sand %	Silt %	Clay %	Fine Clay %
0-4	36.1	50.0	13.9	5.3
4-14	36.0	49.0	15.0	4.8
14-20	36.3	50.1	13.6	5.2
20-26	18.2	57.5	24.3	9.9
26-36	26.5	53.6	19.9	8.3
36-48	21.6	56.6	21.8	5.8
48-70	31.7	56.2	12.1	2.7

11. Location : 7/10 N of SW Cor. 18-53-25 W4

Depth	Sand %	Silt %	Clay %
24-34	7.0	54.0	39.0

12. Location : SW 3-53-26 W4

Depth	Sand %	Silt %	Clay %
0-2			
2-4	51.4	37.8	10.8
4-10	47.9	41.5	10.6
10-16	49.0	40.8	10.2
16-22	75.1	11.0	13.9
22-24	45.0	31.4	23.6
24-68	51.5	36.0	12.5
68-72	67.3	23.7	9.0

13. Location : NE 4-53-26 W4

Depth	Sand %	Silt %	Clay %
0-10	54.1	35.7	10.5
10-22	52.5	36.6	11.5
22-32	51.7	36.1	12.2
32-34	44.5	34.8	20.7
34 +	48.2	37.6	14.2

14. Location : SW 28-54-23 W4

Depth	Sand %	Silt %	Clay %
0-13	26.5	40.5	33.0
13-15	23.5	52.2	24.3
15-28	15.2	34.0	50.8
28-36	39.3	28.1	32.6
36-48	43.3	28.9	27.8

15. Location : NE 32-54-23 W4

Depth	Sand %	Silt %	Clay %
5-6	11.2	39.6	49.2
7-11	6.2	31.8	62.0
12-18	5.0	25.1	69.9
18	2.1	20.6	77.3
48	8.5	36.9	54.6

16. Location : NW 36-54-24 W4

Depth	Sand %	Silt %	Clay %
3-6	13.8	49.4	36.8
1-2	13.4	65.5	21.1
16-24	5.6	28.8	65.6
at 24	4.2	26.2	69.6
at 30	4.2	29.8	66.0
at 48	5.2	46.6	48.2

17. Location : NW 36-54-24 W4

Depth	Sand %	Silt %	Clay %
4-6	9.7	52.4	37.9
6-8	5.3	19.0	75.7
16	4.0	26.2	69.8
48	3.5	42.8	53.7
12-16	4.3	18.3	77.4

18. Location : NW 7-54-25 W4

Depth	Sand %	Silt %	Clay %
0-3	8.2	38.1	53.7
3-10	8.0	41.6	50.4
10-13	7.1	38.9	54.0
13-30	4.9	28.5	66.6
30-40	3.0	22.8	74.2

19. Location : NW 20-54-26 W4

Depth	Sand %	Silt %	Clay %
0-3	14.6	43.2	42.2
3-10	12.6	36.5	50.9
10-14	9.2	33.9	56.9
14-46	1.8	20.6	77.6
46-48	0.8	30.1	69.1

20. Location : NE 34-54-26 W4

Depth	Sand %	Silt %	Clay %
0-4	9.2	45.4	45.4
4-12	4.6	34.3	61.1
12-24	4.6	33.4	62.0
24	5.1	30.8	64.1

21. Location : SW 7-55-22 W4

Depth	Sand %	Silt %	Clay %
0-4	30.4	50.4	19.2
4-5	26.2	57.2	16.6
5-15	19.0	37.5	43.5
15	24.6	30.6	44.8
36-40	39.9	32.5	27.6

22. Location : SW 2-55-24 W4

Depth	Sand %	Silt %	Clay %
0-16	6.5	56.0	37.5
16-19	10.0	66.0	24.0
19-28	2.0	42.0	56.0
28-38	1.0	42.0	57.0
38-44	8.0	66.0	26.0
44-50	-	-	-

23. Location : SW 3-55-26 W4

Depth	Sand %	Silt %	Clay %	Fine Clay %
0-11	9.1	48.6	42.3	16.0
11-13	5.3	45.4	47.3	26.8
13-24	5.5	47.9	46.6	22.6
24-42	8.0	39.4	52.6	19.9
42-48	9.2	40.2	50.6	18.4

24. Location : SW 17-55-26 W4

Depth	Sand %	Silt %	Clay %
0-5	43.0	32.0	25.0
5-12	57.0	20.0	23.0
12-42	57.0	18.0	25.0
42 +	16.0	41.0	43.0

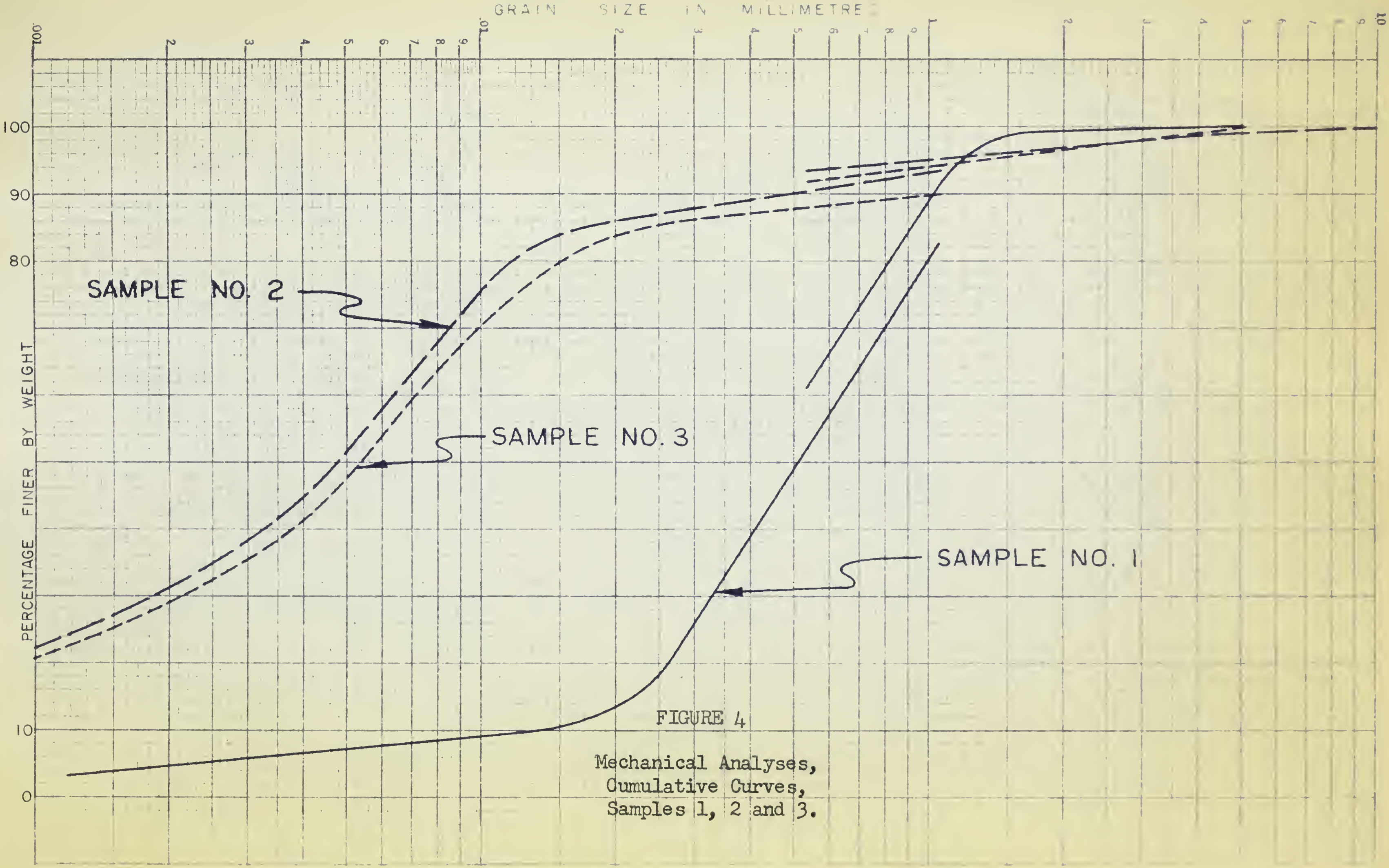


FIGURE 4

Mechanical Analyses,
Cumulative Curves,
Samples 1, 2 and 3.

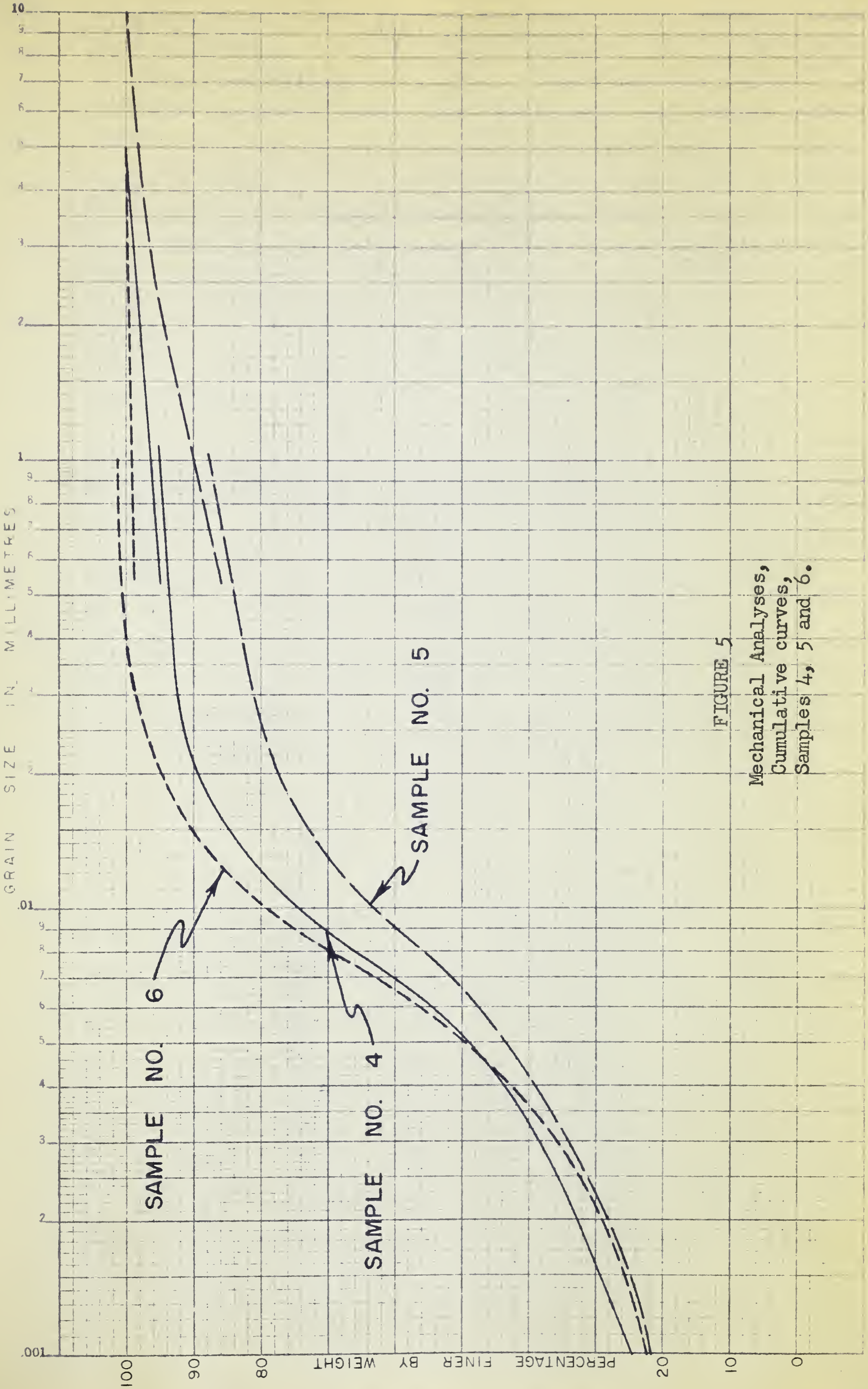


FIGURE 5
Mechanical Analyses,
Cumulative curves,
Samples 4, 5 and 6.

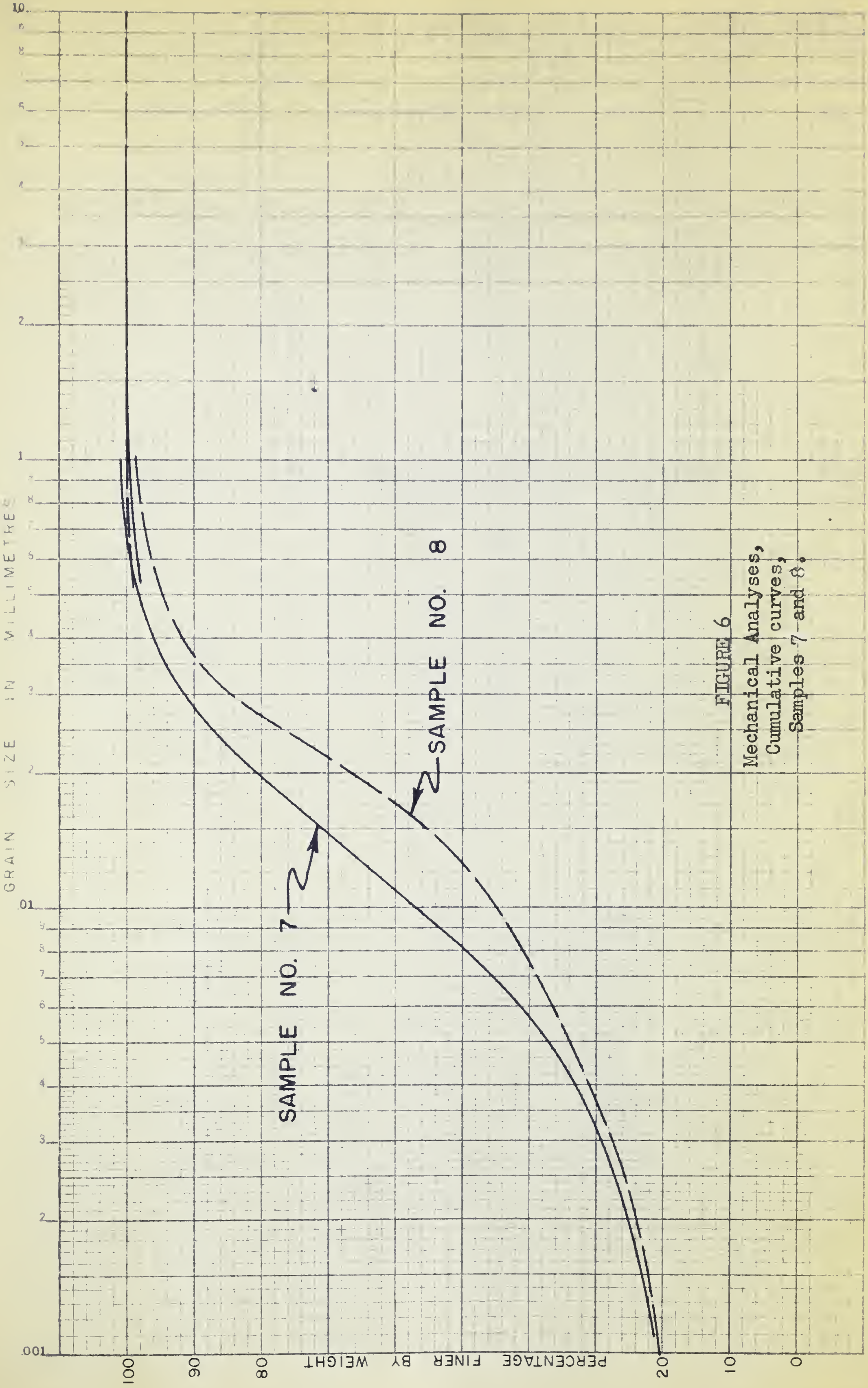


FIGURE 6
Mechanical Analyses,
Cumulative curves,
Samples 7 and 8.

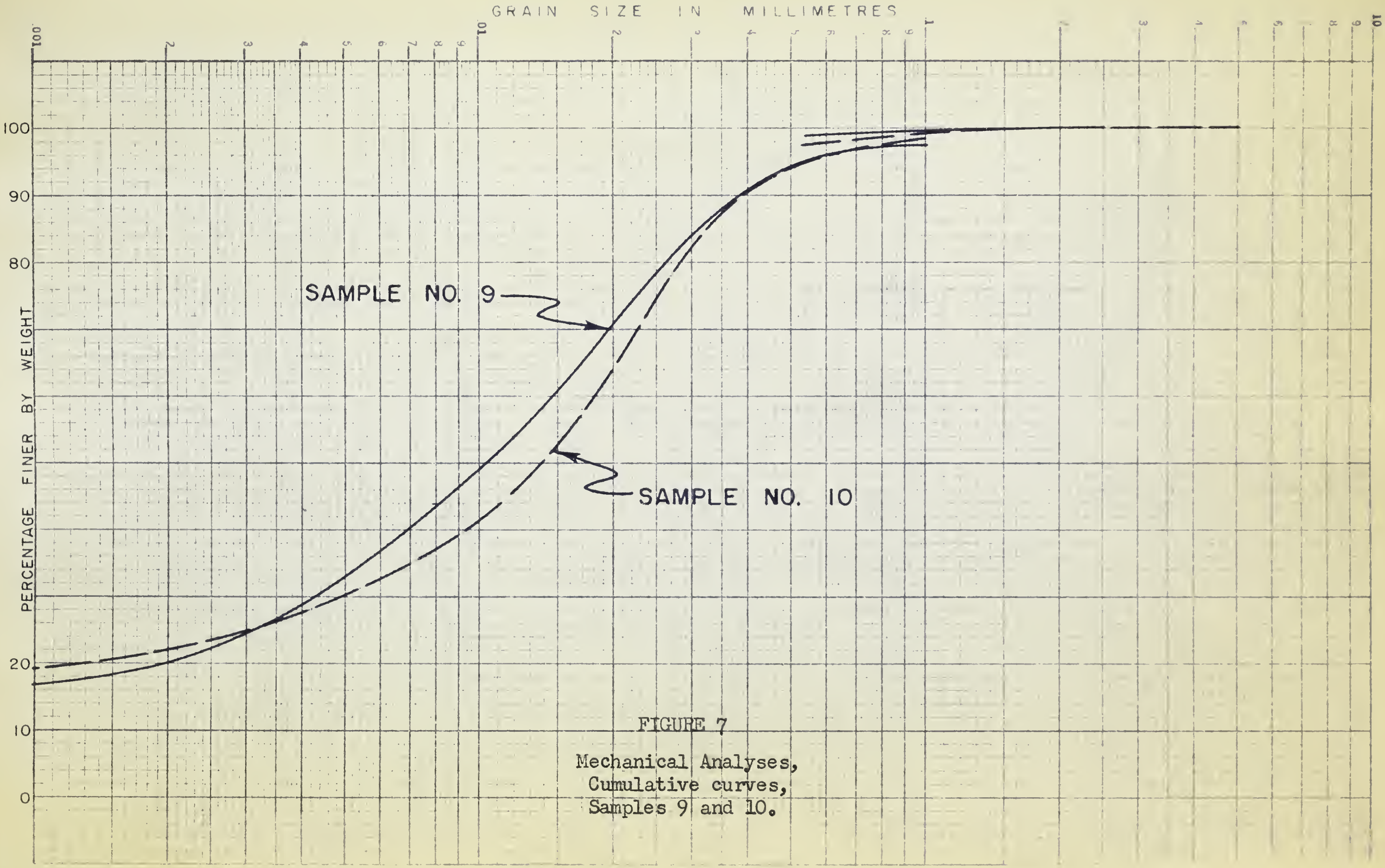


FIGURE 7

Mechanical Analyses,
Cumulative curves,
Samples 9 and 10.

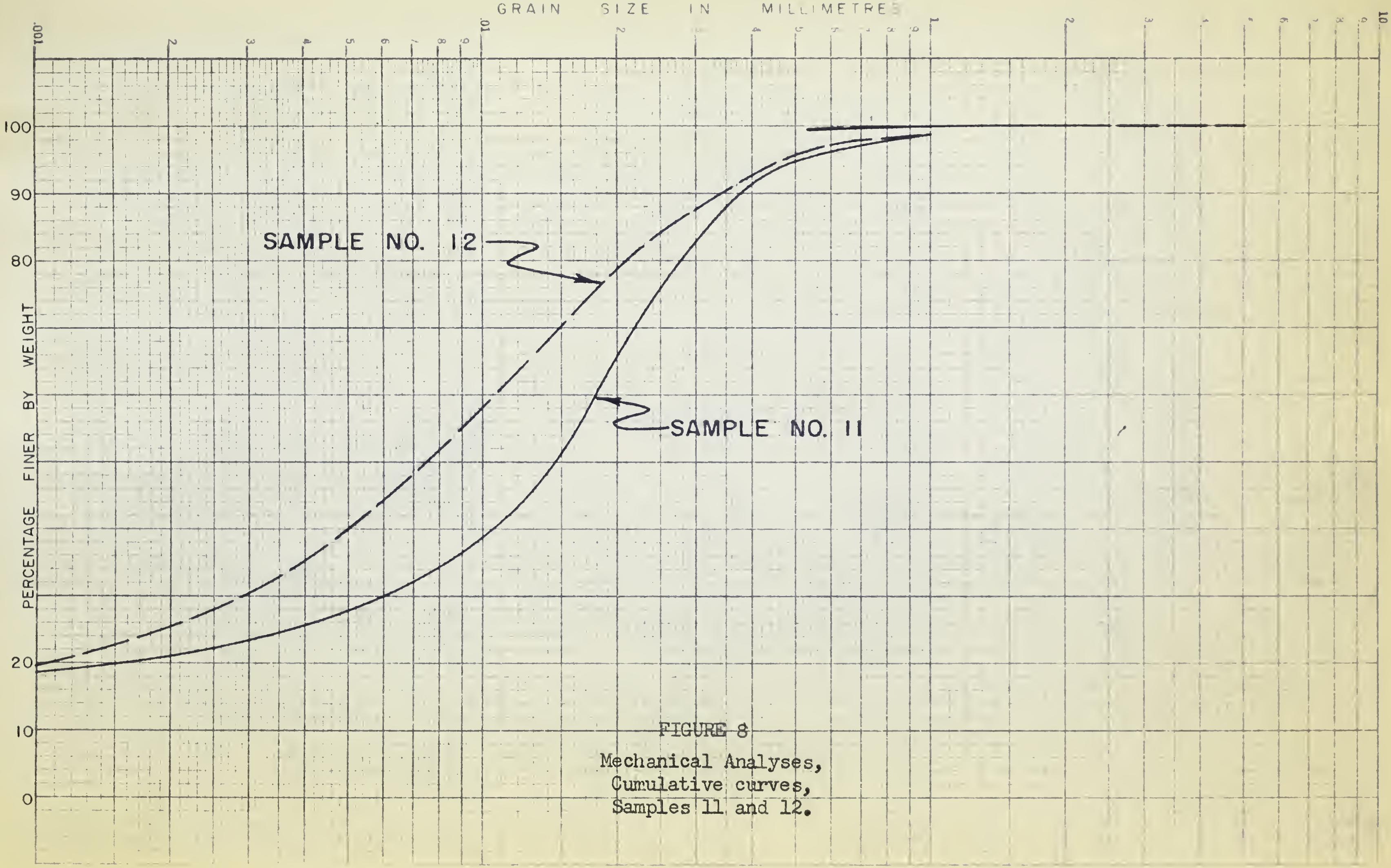


FIGURE 8

Mechanical Analyses, Cumulative curves, Samples 11 and 12.

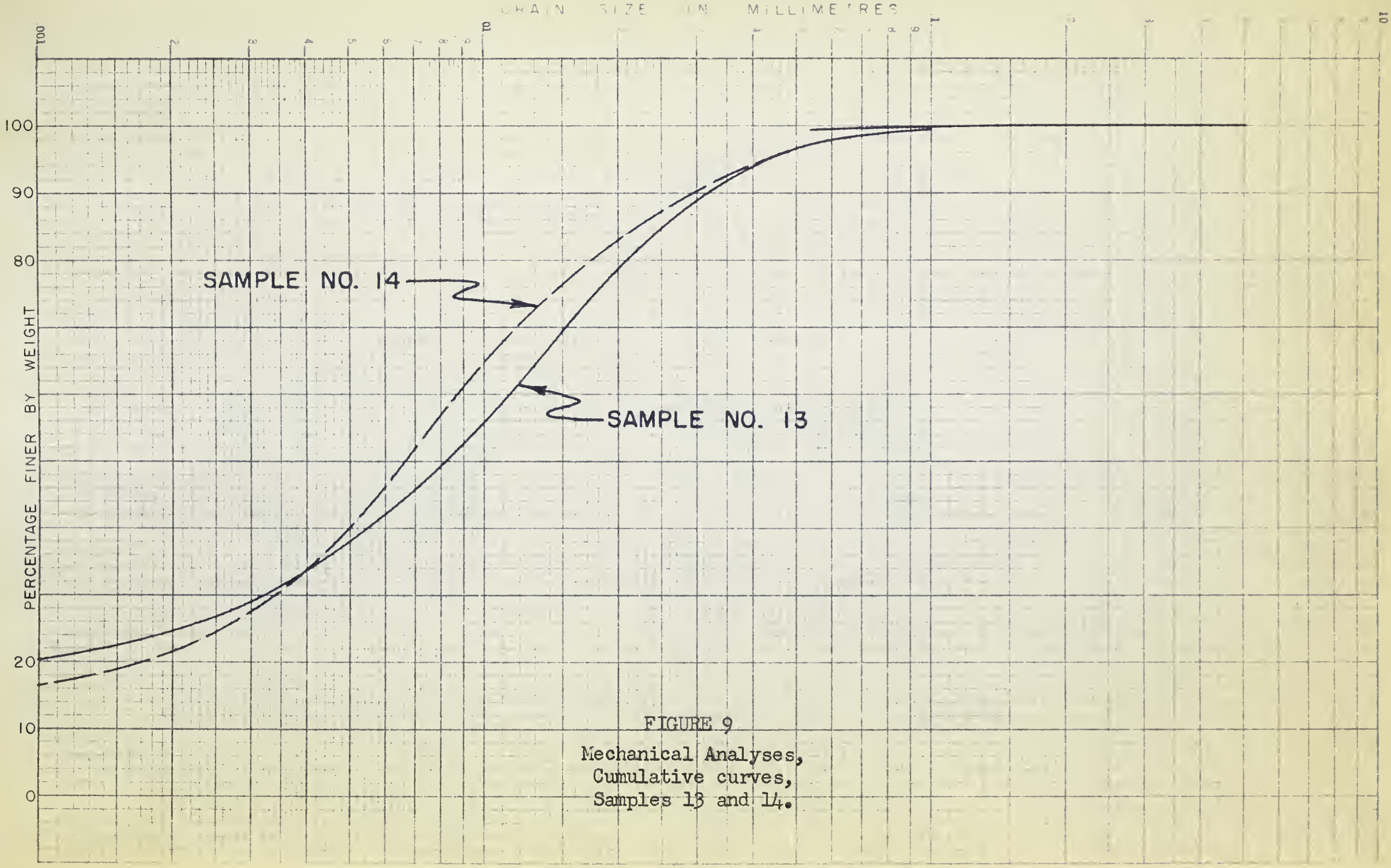


FIGURE 9
Mechanical Analyses,
Cumulative curves,
Samples 13 and 14.

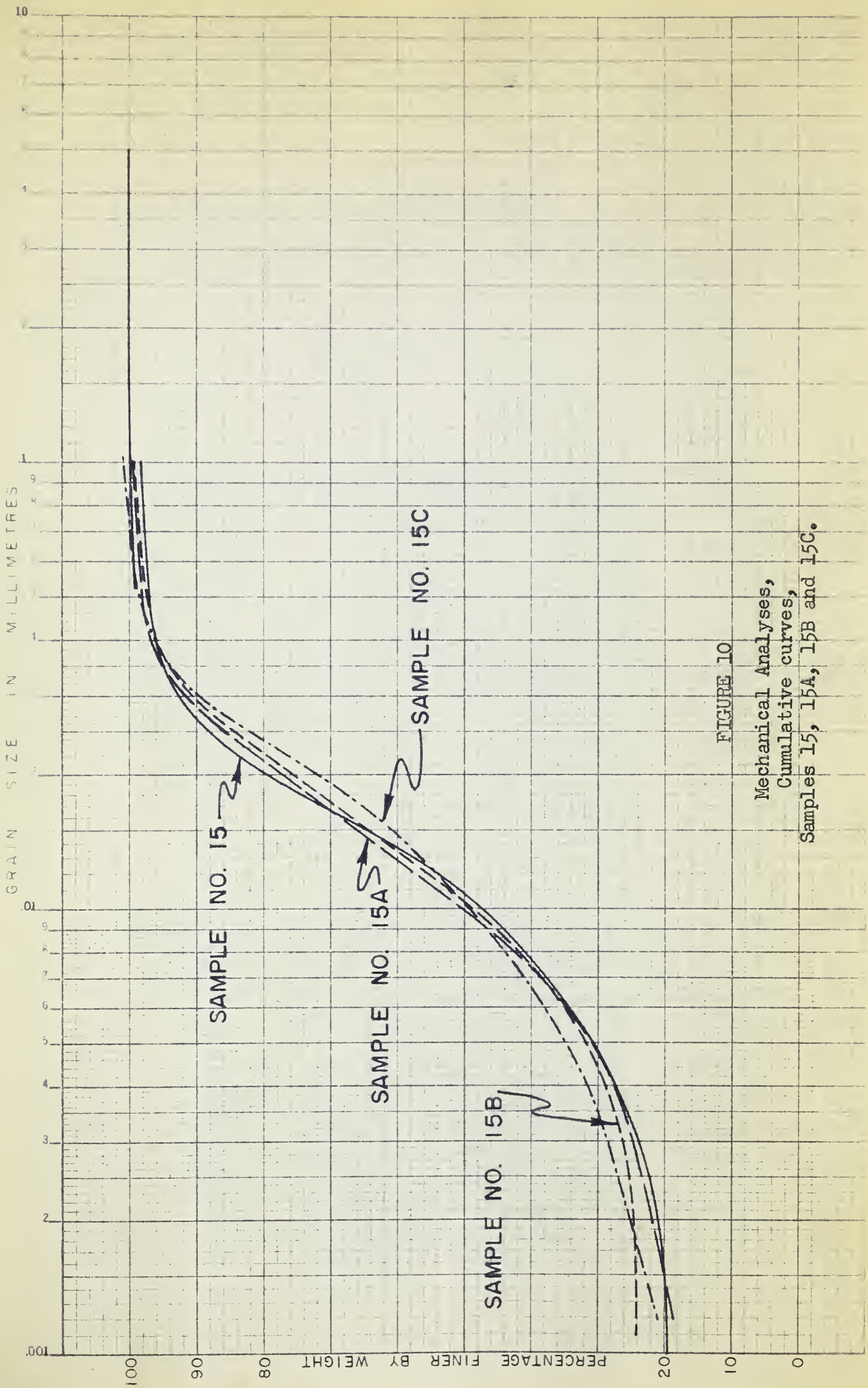


FIGURE 10
Mechanical Analyses,
Cumulative curves,
Samples 15, 15A, 15B and 15C.

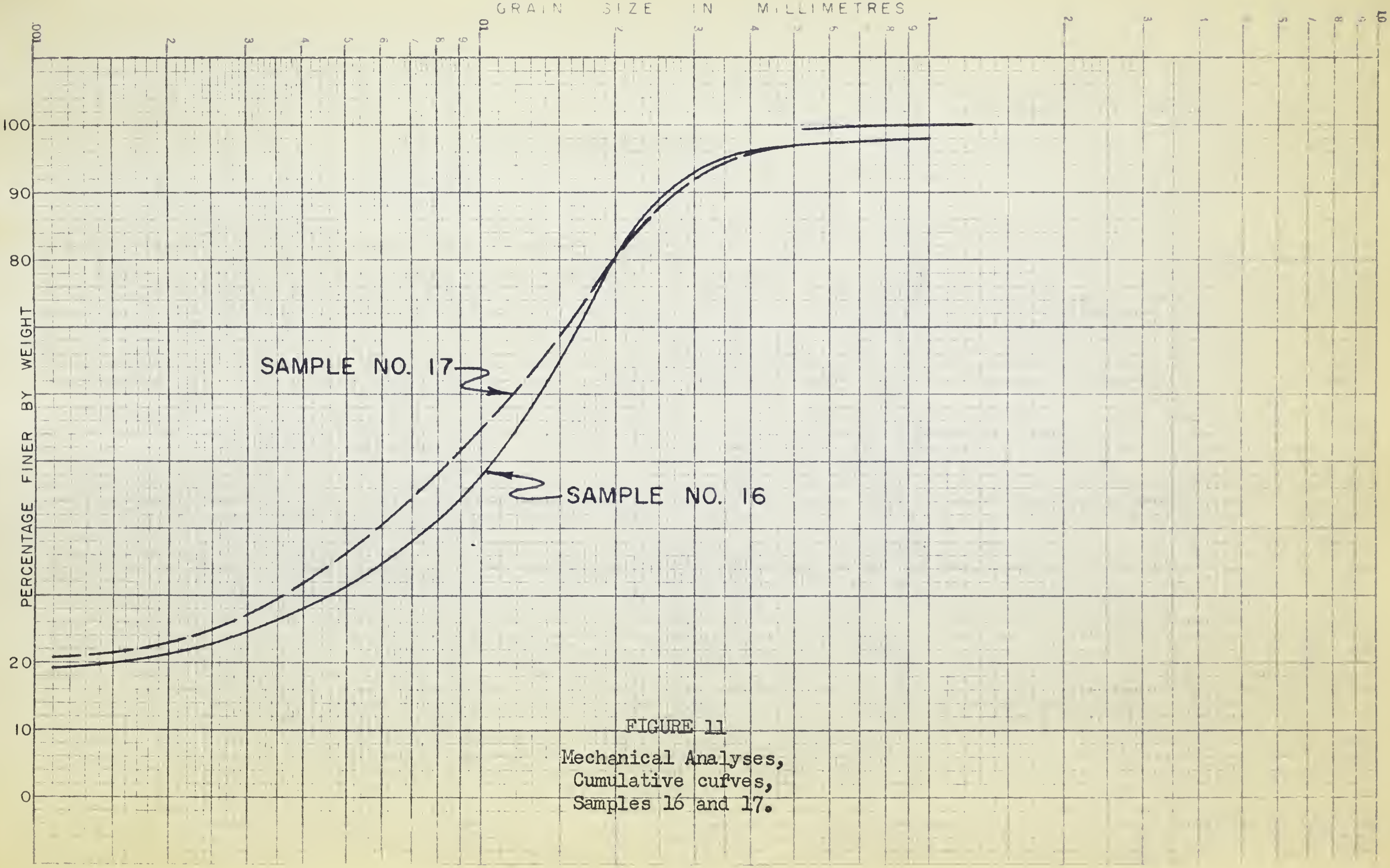


FIGURE 11

Mechanical Analyses,
Cumulative curves,
Samples 16 and 17.

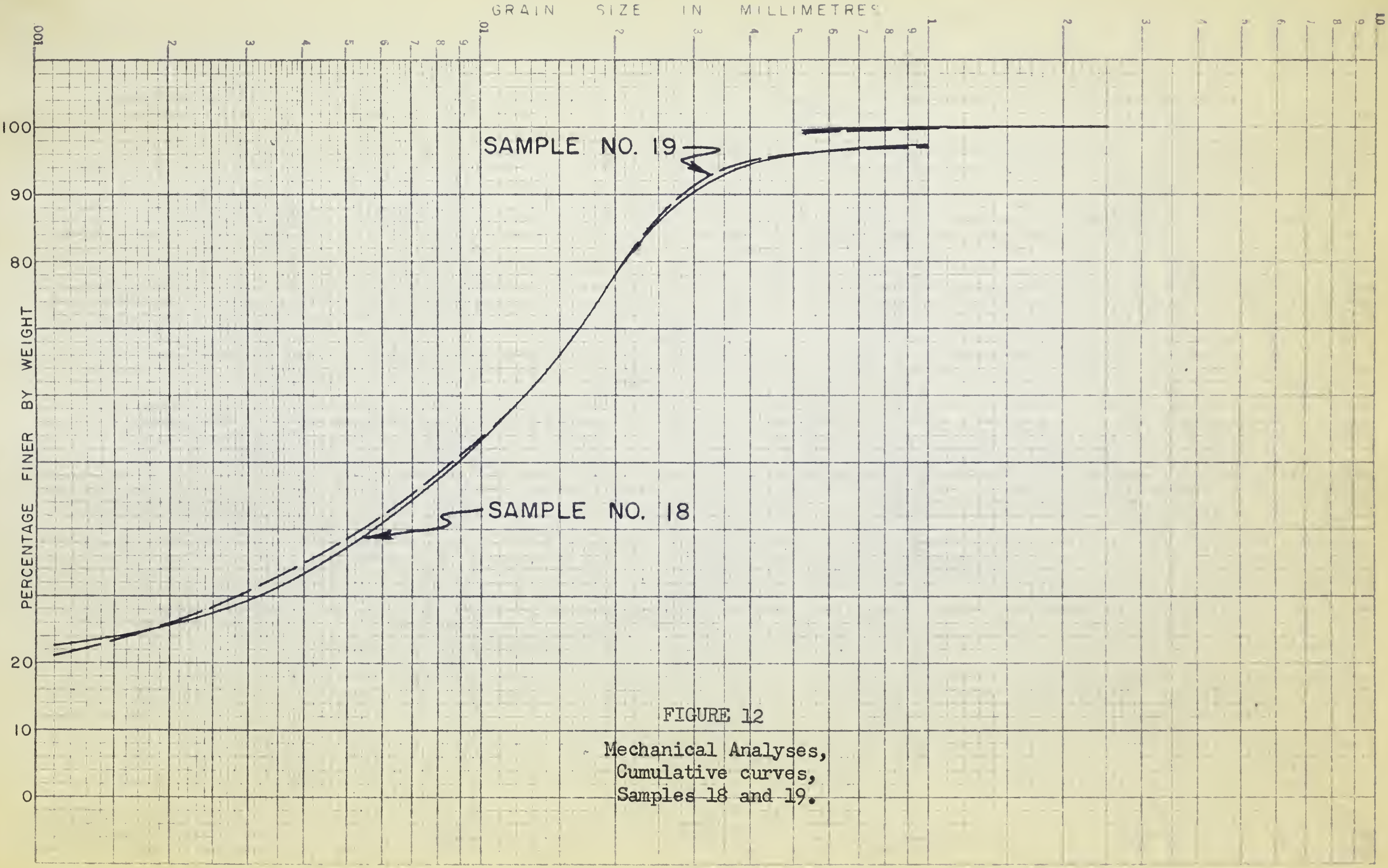


FIGURE 12

Mechanical Analyses,
Cumulative curves,
Samples 18 and 19.

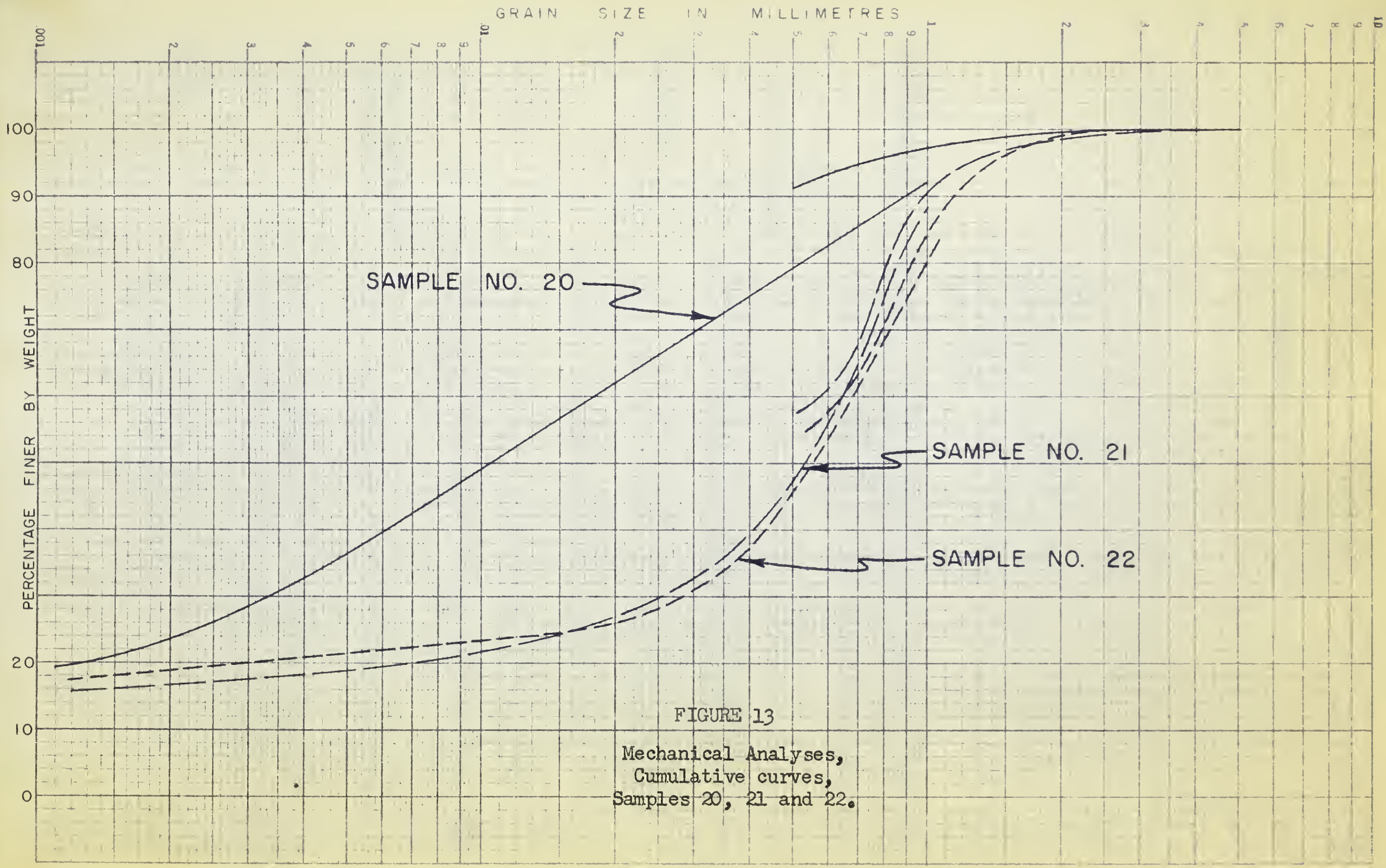


FIGURE 13

Mechanical Analyses,
Cumulative curves,
Samples 20, 21 and 22.

APPENDIX B

GLOSSARY

Alluvium.	"The rather consistent usage of the term throughout its history makes it quite clear that alluvium is intended to apply to stream deposits of comparatively recent time, that subaqueous deposits of seas and lakes are not intended to be included, and that permanent submergence is not a criterion. Alluvium may become lithified, as has happened frequently in the past and then may be termed ancient alluvium." (Glossary of Geology and Related Sciences, Amer. Geol. Inst. 1957).
Anastomosing.	As anastomosing stream = Braided stream. Branching, interlacing, intercommunicating, thereby producing a net-like or braided appearance. (Glossary of Geology and Related Sciences, Amer. Geol. Inst. 1957).
Consequent Valley.	"One whose course was determined by the initial slope of the land." (Thornbury, W.D., Principles of Geomorphology: 1956, New York, John Wiley and Sons Inc., p.113).
Flutings.	"- - - - groups of ridge-like and groove-like land forms combining to impart a fluted pattern to the surface." (Flint, R.F., 1957, Glacial and Pleistocene Geology: New York, John Wiley and Sons, Inc., p.66).
Fluvial.	Of, or pertaining to rivers; growing or living in streams or ponds; produced by river action, as a fluvial plain. (Glossary of Geology and Related Sciences, Amer. Geol. Inst. 1957).
Fluvial-lacustrine deposits.	Deposits of either or both fluvial and lacustrine origin; inseparable.
Inwash.	Alluvium, mainly of non-glacial origin, mingled with outwash or accumulated against the margin of a glacier. Modified from - Flint, R.F., 1957, Glacial and Pleistocene Geology: New York, John Wiley and Sons, Inc., p.138).
Kame.	A low steep-sided hill of stratified drift, formed in contact with glacier ice. (Glossary of Geology and Related Sciences, Amer.Geol. Inst. 1957).

<u>Kame-moraine</u>. A group of closely spaced kames. (As used herein, for a full description of the variety of kame-moraine forms, see Charlesworth, J.K., 1957, The Quaternary Era: London, W.C. Clows and Sons, Ltd., p.415-420).

<u>Lacustrine</u>. Produced by or belonging to lakes. (Emmons, Ebenezer, Man. of Geol., 1860).

<u>Muck</u>. A dark coloured soil commonly in wet places, which has a high percentage of decomposed or finely comminuted organic matter. (Glossary of Geology and Related Sciences, Amer.Geol. Inst. 1957).

<u>Outwash</u>. "- - - Stratified drift that is stream built ("washed out") beyond the glacier itself." (Flint, R.F., 1957. Glacial and Pleistocene Geology: New York, John Wiley and Sons, Inc., p.136).

<u>Superglacial lake</u>. Lake formed on the surface of a glacier.

LEGEND

QUATERNARY
RECENT

CENOZOIC

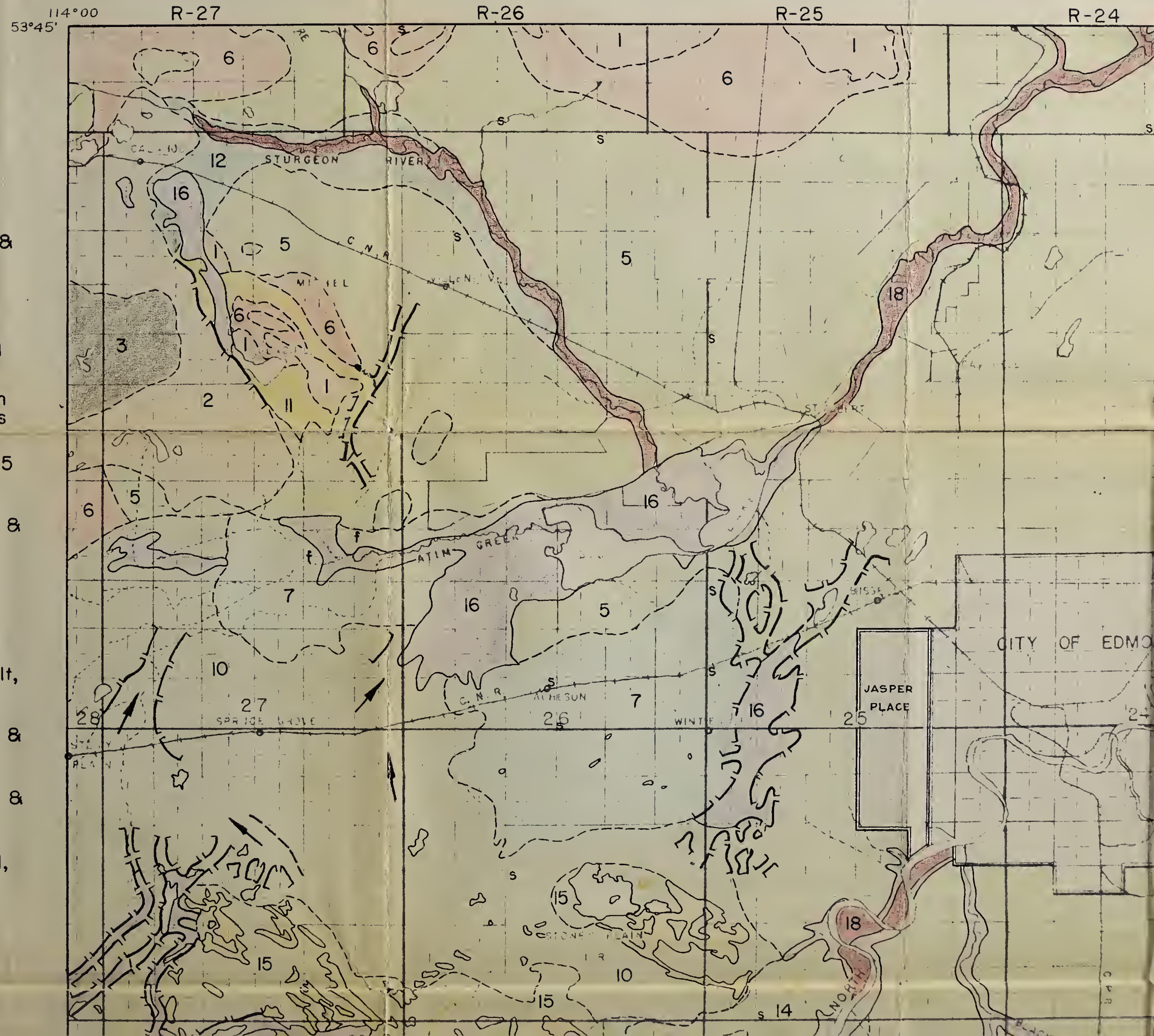
18	Alluvium-gravel, sand & silt
17	Colluvium-sand, silt & clay
16	Lacustrine deposits-peat, clay, sand, silt & marl

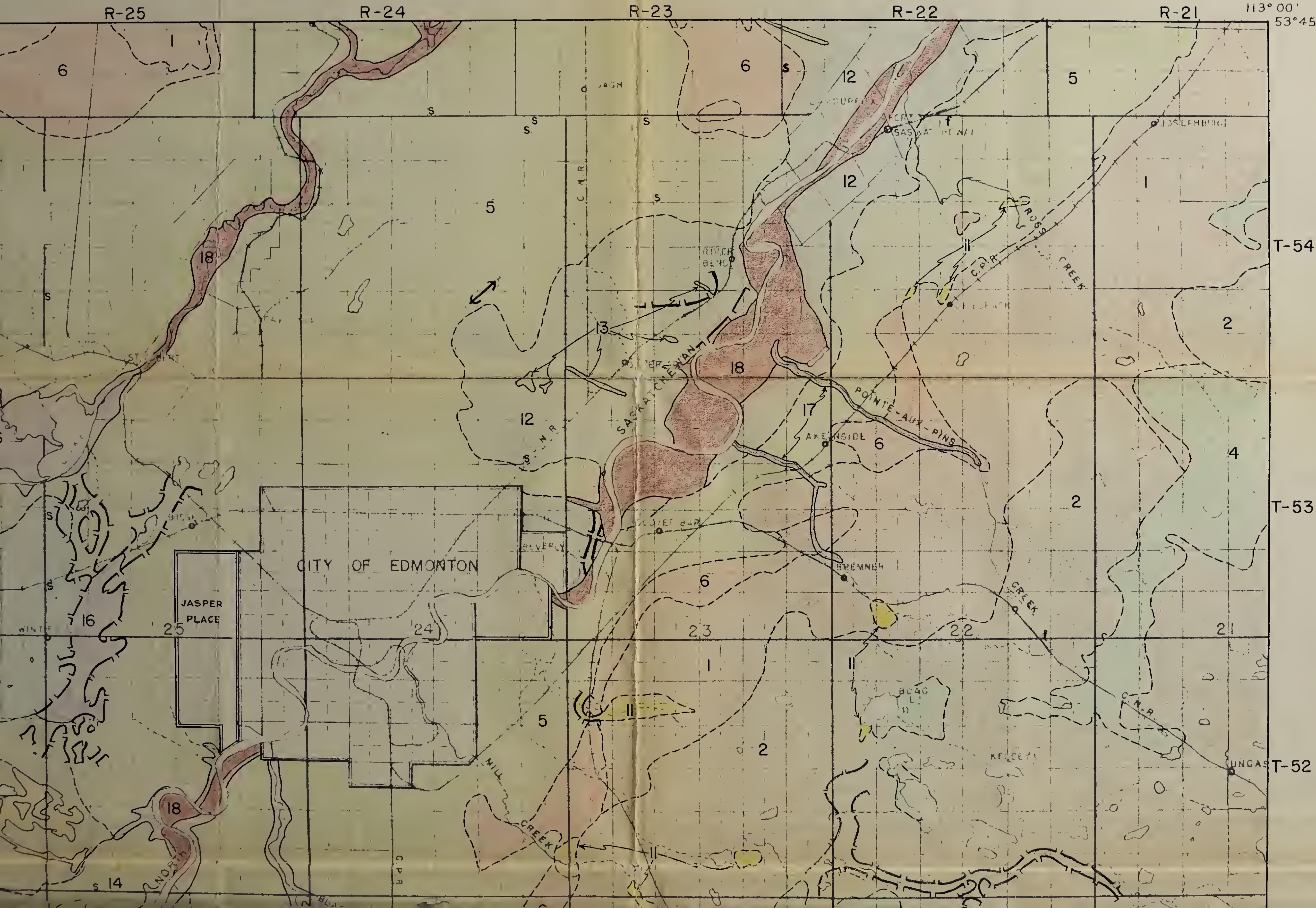
PLEISTOCENE TO RECENT

15	Aeolian deposits, sheet: sand & silt less than 5 feet thick overlying water-reworked inwash
14	Aeolian deposits, sheet: sand & silt less than 5 feet thick overlying Lake Edmonton silts & clays
13	Aeolian deposits, dunes: sand & silt over 5 feet thick
12	Fluvial-lacustrine deposits: sand, silt, clay & gravel

PLEISTOCENE

11	Outwash deposits: sand & gravel
10	Water-reworked inwash deposits: sand, silt, clay, & some gravel
9	Water-reworked deposits: sand, silt, clay & some gravel overlying till
8	Water-reworked deposits: sand, silt, clay & some gravel overlying Lake Edmonton deposits
7	Pitted inwash deposits: ice-contact sand, silt, & clay with some gravel
6	Transition zone deposits: 10% to 90% Lake Edmonton deposits, balance till
5	Lake Edmonton deposits: over 90% lacustrine silt, clay & some sand, balance till





R-25
R-24
R-23
R-22
R-21
113° 00'
53°45'
T-54
T-53
T-52
CITY OF EDMONTON
JASPER PLACE
SASKATCHEWAN
POINTE-AUX-PINS
ROSS CREEK
MILL CREEK
C.P.R.
C.N.R.
BREMNER
BEVERLY
AKENSIDE
NORTH

6	Lake Edmonton deposits, balance till
5	Lake Edmonton deposits: over 90% lacustrine silt, clay & some sand, balance till
4	Superglacial lake deposits: clay, silt & sand
3	Kame moraine
2	Hummocky dead-ice moraine
1	Ground moraine

Scouring (arrow points downslope)

Stream trench or channel

Geological boundary defined

Geological boundary assumed

Flutings

f Fossil locality

s Mechanical analysis

Township boundary

Section line

Railway

53°15'
114°00'

GLACIAL GEOLOGY EDMONTON DISTRICT

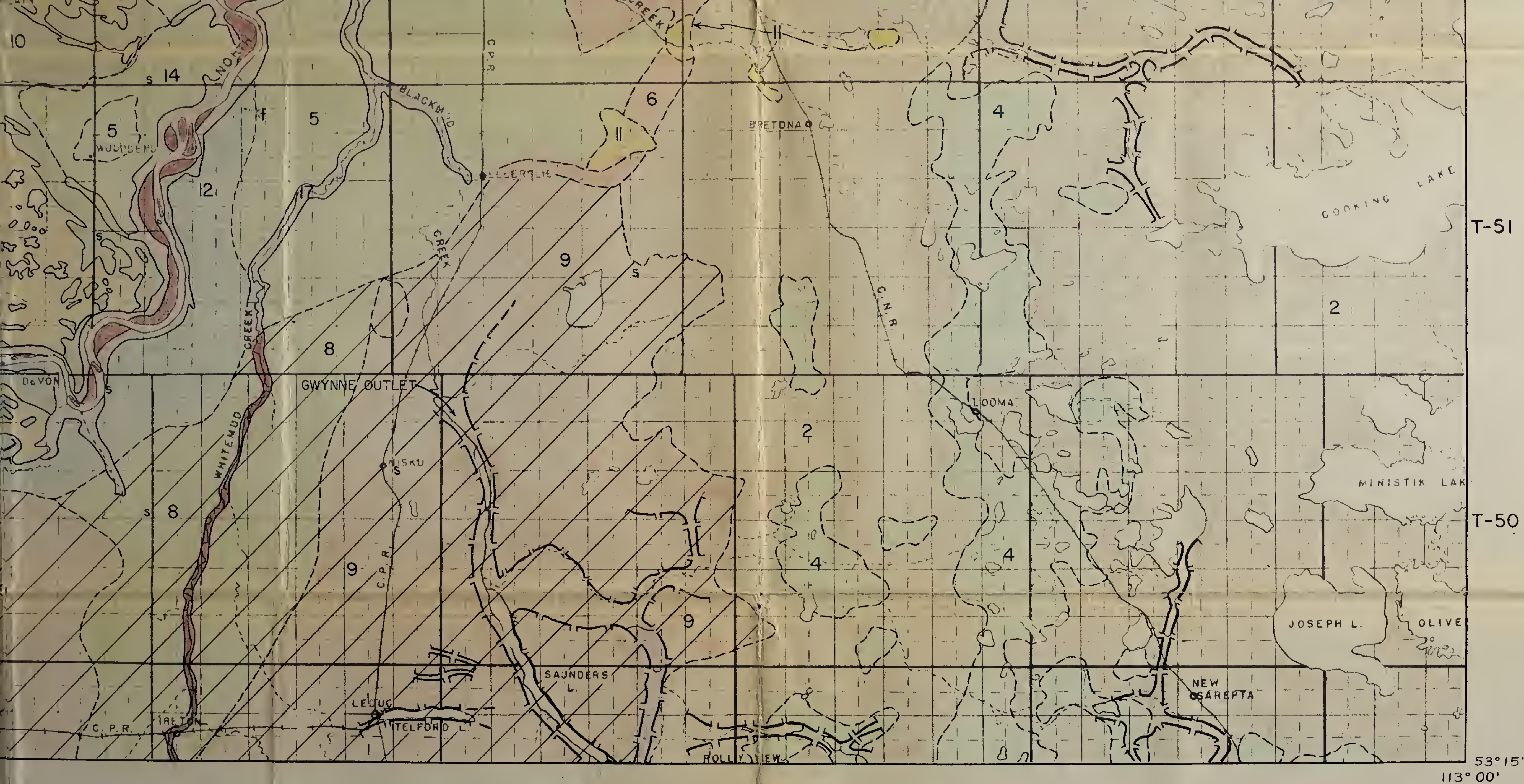
WEST OF THE FOURTH MERIDIAN

ALBERTA

Scale: 1 inch to 2 miles $\frac{1}{126,720}$

0 2 4 6

PLATE 1



GLACIAL GEOLOGY
EDMONTON DISTRICT

WEST OF THE FOURTH MERIDIAN
ALBERTA

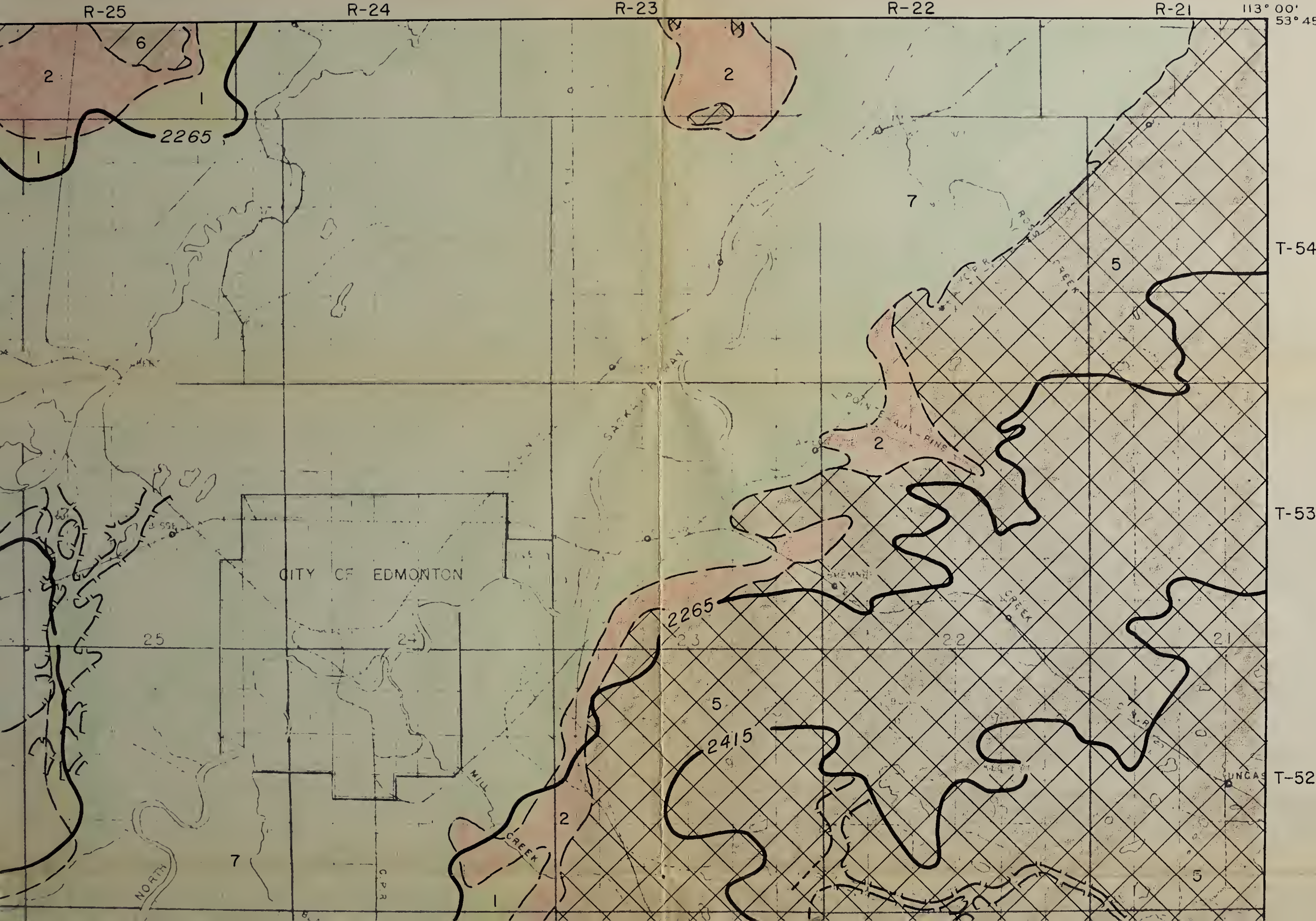
Scale: 1 inch to 2 miles $\frac{1}{126,720}$

0 2 4 6

PLATE 1

LEGEND

- 7 — Lake Edmonton deposits-stages I & 2
- 6 — Ice present at end of stage I in addition to ice present at end of stage 2
- 5 — Ice present at end of stage 2
- 4 — Pitted inwash deposits
- 3 — Deltaic deposits
- 2 — Transition zone deposits
- 1 — Lake Edmonton deposits-stage I only
- Scouring (arrow points downslope)
- Stream trench or channel
- Contour line on present surface
- Township boundary
- Section line
- Railway



R-25
R-24
R-23
R-22
R-21
113° 00'
53° 45'
T-54
T-53
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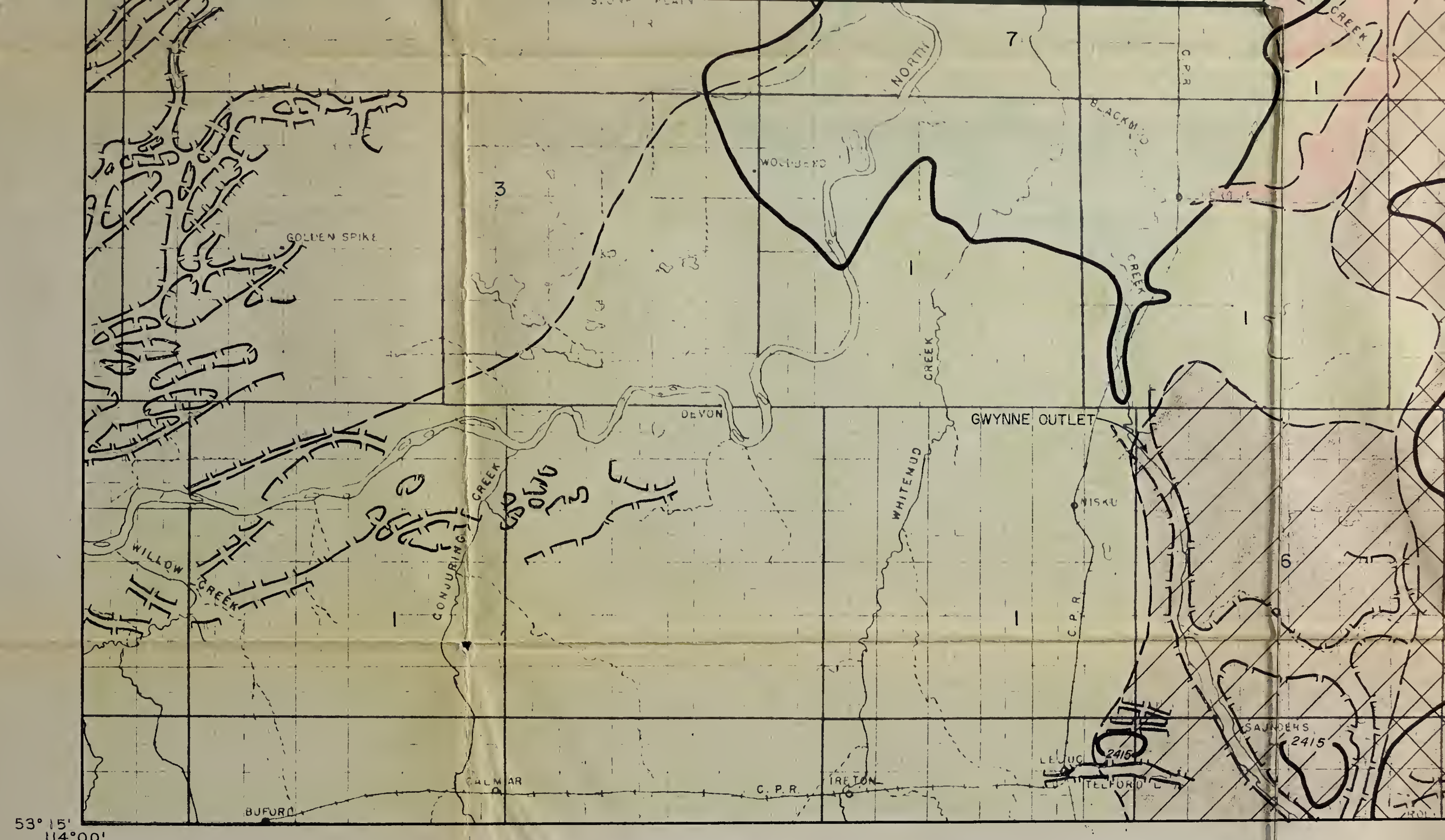
2265
2415
CITY OF EDMONTON
ROSS CREEK
POINTE AUX PINS
MILL CREEK
NORTH
C.P.R.
UNCAS
25
23
22
21
7
5
2
1
6



RECONSTRUCTION OF LAKE EDMONTON
EDMONTON DISTRICT

WEST OF THE FOURTH MERIDIAN
ALBERTA

Scale: 1 inch to 2 miles $\frac{1}{126,720}$

0 2 4 6

PLATE 2

ISTRUCTION OF LAKE EDMONTON
EDMONTON DISTRICT

WEST OF THE FOURTH MERIDIAN
ALBERTA

Scale: I inch to 2 miles $\frac{1}{126,720}$

0 2 4 6

PLATE 2